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Research Paper

VISIONARY INDUSTRIAL APPROACH OF ENCAPSULATION: AN ADVANCED BIOCHEMICAL ENGINEERED TECHNIQUE

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Abstract

Encapsulation is an advanced biochemical engineering tool to immobilize/bind/entrap any chemical and biological ingredient into suitable chosen matrices. This is effective biochemical approach to increase the stability and efficacy of immobilized materials as compared to its native forms. This method helps to protect the functional core of compounds such as enzymes, antioxidants, polyphenol and micronutrients to carry out their controlled delivery to target site and to protect them from adverse environmental conditions. It has novel applicative approach in drug delivery systems over conventional multi dose therapy by increasing its potential on controlled and sustained release bound dosage forms at target sites to get optimum benefits. The intent of this review article is to highlight the potential of encapsulation technique as an emerging biochemical engineered vital tool in various medical and industrial practices used for betterment of mankind. Encapsulation is enabled to alter the colloidal and surface properties of entrapped any chemical and biological materials along with the chosen matrices which also provide the stability against prevailing conditions and microbial resistance by controlling the release characteristics or availability of bound materials. Encapsulation was commonly done by solvent evaporation/extraction methods have been widely used to prepare microspheres and nanospheres loaded drugs, enzymes, antioxidants, polyphenol and micronutrients.

Key words: Encapsulation, entrapment, immobilization, controlled release, sustained release, target site, therapeutic efficacy, novel drug delivery.

INTRODUCTION

Encapsulation technology has remarkable applications in a wide range of industries due to its noticeable cost effectiveness. It is the process in which core material of chosen matrix was biochemically engineered by chemical alteration with bioactive compounds to form a small sphere or capsule in which useful chemically and biological ingredient was bound further. Therefore, bound functional bioactive compounds provide many health benefits in the prevention and treatment of many diseases.[1] Microencapsulation and nanoencapsulation have also been used for long-term delivery of protein drugs and parenteral administration of protein drugs in microspheres made of biodegradable polymers. Preparation of protein drug-containing microsphere without reducing bioactivity has been the goal of microencapsulation methods.[2] Compared with chemical drugs, peptide and protein drugs have some disadvantages such as low stability due to time mediated deactivation with short half-life and also having difficulty in being adsorbed following oral administration due to having high molecular weight.[3-5] Biodegradable polymers and particulate carriers have been shown to have a high potential for the delivery of peptides and proteins by oral administration.[6] A number of encapsulation methods have been developed and these are solvent evaporation/extraction; phase separation (coacervation); spray drying; ionotropic gelation/polyelectrolyte complexation; interfacial polymerization; and supercritical fluid precipitation. Solvent evaporation/extraction methods have been widely used to prepare microspheres and nanosphere loaded with various drugs, peptide, antioxidants, polyphenol, enzymes and other micronurtients by oil/water (o/w), oil/oil (o/o) and water/oil/water (w/o/w) emulsification methods.[7,8]

MICROENCAPSULATION METHODS

SOLVENT EVAPORATION

Single emulsion solvent evaporation method has been used to prepare microspheres/nanospheres containing various peptide and protein drugs. Insulin solution in organic solvent was used in emulsification to prepare nanospheres.[7] Other researchers used solid particles of bovine serum albumin (BSA). This approach resulted in high encapsulation efficiency (88%) and high activity of the loaded enzyme (95%).[7,8] In double emulsion methods, an aqueous drug solution is first emulsified in a polymer-dissolved organic solvent followed by emulsifier, thereby forming w/o/w emulsion. Then, the organic solvent is removed by extracting into external aqueous phase and evaporation. Small peptide drugs with low aqueous solubility can be successfully encapsulated into polymer microspheres for sustained delivery.[8,9]

PHASE SEPARATION (COACERVATION)

Microencapsulation by phase separation is basically a three-step process: (1) phase separation of the coating polymer to form coacervate droplets; (2) adsorption of the coacervate droplets onto the drug surface; and (3) solidification of the microcapsules.[10] Phase separation techniques can be classified according to the method to induce phase separation; nonsolvent addition, temperature change, incompatible polymer or salt addition, and polymer-polymer interaction.[11]

IONOTROPIC GELATION /POLYELECTROLYTE COMPLEXATION

Ionotropic gelation (IG) is based on the ability of polyelectrolytes to crosslink in the presence of counter ions to form hydrogels. Alginate is widely used for ionotropic gelation to bind for both cell and drug encapsulation.[12]

ALBUMIN MICROSPHERES

Various natural polymers have received attention in the development of suitable sustained drug delivery systems. Albumin microspheres have been used as carriers for the delivery of wide range of drugs– anticancer, antifertility, antihistamines and antituberculosis.[13-16]. Egg albumin microspheres have been widely biochemically fabricated for drug deliveryto carry out delivery of both hydrophilic and lipophilic drugs and bound ingredients. Egg albumin microspheres of norethisterone are prepared by simple multiple emulsion technique and heat denaturizing process. This covalent crosslinking process can be accomplished either thermally or by the addition of a chemical crosslinking agent.[17] There has been increasing interest in the use of alginate and chitosan in drug delivery systems, mainly because of their non-toxic, biocompatible, biodegradable and mucoadhesive properties.[18,19] Furthermore, chitosan has been shown to enhance penetration through mucosa and remarkable efficacy when used for oral absorption enhancer.[20] The preparation of alginate microparticles has been achieved mainly by interfacial crosslinking with an external or internal calcium source.[21,22] The main disadvantage in using calcium cross-linking directly is the difficulty in obtaining very small sized microparticles which are preferable to stabilize the fragile structure of the drug and control its release. Hence, bovine serum albumin (BSA) was used as a model protein and alginate and chitosan as carrier materials for preparing BSA loaded alginate/chitosan microspheres by a modified emulsifying-gelatinization method.23] Previously, amylase bound egg albumin microspheres and nanospheres was prepared by emulsification and desolvation method respectively.[24,25] Mustard oil and olive oil were also used as emulsifier to entrap the amylase in chemically modified bovine serum albumin.[26,27] Coconut oil driven emulsified bovine serum albumin microspheres were also used to encapsulate glucose oxidase.[28] Chemically modified bovine serum albumin was used biocompatible biomatrix to immobilize pulses amylases and its alkaline protease mediated biodegradation was also done for controlled and sustained release of bound enzyme in delivery system.[29-32] Toluene driven egg albumin preparation was previously chosen to entrap the amylase and glucose oxidase.[33,34] Bovine serum albumin was biochemically modified to immobilize the amylase in its nanopreparation to increase the stability and efficacy of bound amylase as compared to free amylase.[35] Bovine serum albumin entrapped amylase was found to be with its % of encapsulation in the chosen matrix and further its remarkable industrial approach in detergent powder for desizing of fabrics.[36] Controlled release technology has emerged as an advanced tool in the development of pharmaceutical dosage forms.[37] At present, protein delivery is a thrust area of research due to the recognized necessity of improving the *in vivo* efficacy of the currently being developed therapeutic as well as antigenic proteins and are incapable of diffusing through biological membranes, are unstable in the gastrointestinal (GI) tract,and also have low bioavailabilities due to their large molecular weight and high aqueous solubility.[38,39,40] Thus, development of sustained release parenteral dosage forms for protein delivery becomes necessary to overcome the problems of patient incompliance and inconvenience where the therapy is required over months and years in chronic diseases.[41] Biodegradable drug delivery system have been used to deliver a variety of therapeutic substances such as proteins, peptides, NSAIDs (nonsteroidal-anti-inflammatory drugs), antibiotics and anticancer drugs in recent years because of their biocompatibility and degradation *in vivo*, to toxicologically acceptable lactic and glycolic acids which are further eliminated by the normal metabolic pathways and approved by US FDA. Although a wide range of microencapsulation techniques have been developed for the preparation of sustained release delivery, the method of preparation has much influence on the properties of microspheres and therefore the desired properties should be kept in mind during the selection of a particular method of preparation.[42]

CONCLUSION

Therefore, it was concluded that encapsulation is outstanding cost effective, safe and eco-friendly biochemical engineered approach used for entrapment of industrial important any chemical and biological ingredients to increase its stability and resistivity towards chemical, microbial and biological shocks as compared to their native forms. Hence, this advanced biochemical approach is effective tool which might be prove very helpful for better of mankind especially used in preparation of industrial production of chemicals and pharmaceutical preparations. It has also potential effective tool for binding of drugs and microbial cells in combating various diseases such as cancer, tuberculosis, arthritis and other epidemics too.

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