Pharmaceutical Applications and Patents in Natural Polymer Based Drug Delivery System

Rishi Kumar, Rishabha Malviya and Promod Kumar Sharma

Department of Pharmacy, School of Medical and Allied Sciences, Galgotias University, Greater Noida, Uttar Pradesh, India

Abstract: Natural polymers have shown an increasing interest in the field of medical science. These have been used in the different dosage form that helps in the sustain and control release of drug. Now a day natural polymers are used in novel and conventional dosage form directly or indirectly. Natural polymers used in various formulations like microspheres, nanoparticles, tablets, gels, implants, niosomes, liposomes etc have shown the additional effect which is helpful in growing up the property of the system. This review summarizes the applications of various natural polymers used in different drug delivery system.

Key words: Natural Polymer · Nanoparticles · Microsphere · Patents

INTRODUCTION

Natural Polymer: Nature is blessed with numerous varieties of polymers. When two or more than two small molecule combines together they form large molecule. The process that is called as polymer synthesis is the process in which 'large molecule is composed of small molecule that are attached together in a monomeric unit to form the larger forms. The common example of this synthesis include the formation of starch molecules by the combination various glucose unit. Cellulose is the most abundant organic compound. Its natural form is cotton and is obtain from the woolly parts of trees [1]. Polysaccharide chitin is similar to cellulose. It is a present in the cell walls of fungi and is the fundamental substance in the exoskeletons of crustaceans, insects and spiders [2]. Nucleotide ribose sugar used in place of dioxin ribose sugar thymine replace by uracil in the RNA formation [3].

Gums are used as a pathological product. There are formed by injuring plant parts or under the unfavourable condition such as drought, by break down of cell walls. Gums readily dissolve in water [4]. Mucilage is generally normal products formed by the metabolism (Physiological product) within the cell (Intracellular formation). Mucilage dissolve in water formed slimy masses. Both gums and mucilage’s are plant hydrocolloids yielding mixture of sugars [5]. Hydrogels are used as a polymer. Hydrogel absorb or retain large amount of water [6]. Pectin is one of the major constituents of citrus by products and has good gelling properties. Pectin is an excellent carbohydrate polymer derived from mainly natural resources and it is the structural component of plant cell wall. Pectin has unique gel forming ability in presence of divalent cation which makes it an ideal carrier for delivering bioactive agents [7]. Different applications of naturally derived polymers are shown in Table 1.

Microsphere: Microspheres are mainly free flowing powders. These consist of proteins or synthetic polymers, which are biodegradable in nature having the particle size is less than 200µm. These are used for drug targeting. They play an important role in sustain and control release of drug [39]. Different natural polymers used in the formulation of microsphere are shown in Table 2.

Nanoparticles: Nanoparticles are the solid particles having the size range of 10-1000nm. They are defined as the particulate dispersion. Polymer used in the nanoparticles formation must be biocompatible or biodegradable. Nanoparticles are used as a carrier system for novel drug delivery. Nanoparticles are use as a particular drug delivery system. Nanoparticles have been used to improve the pharmacokinetic or pharmacodynamic properties of various types of drug molecules.
Carrier nanoparticles show desirable pharmaceutical or medical field result. Nanoparticles are used for controlled and sustain release drug delivery system. Nanoparticles surface is playing a key role in drug targeting. Hydrophobic polymer is mainly used for surface modification of the nanoparticles this is done by coating it with a polymer such as poly (Ethylene glycol) PEG or biodegradable polymer poly (Lactic acid) and poly (Lactic-co-glycolic acid) thus hydrophilic PEG chains allows to control the protein and peptide absorption, in addition it will allows the regulation of cell behaviour on the polymer surface [61-63]. Different natural polymers used in the formulation of nanoparticle are given in Table 3.
Table 3: Natural polymers used in the formulation of nanoparticles

<table>
<thead>
<tr>
<th>S.No</th>
<th>Drug</th>
<th>Polymer</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Quercetin, 5-fluorouracil</td>
<td>Pectin</td>
<td>64, 65</td>
</tr>
<tr>
<td>2</td>
<td>Aspirin</td>
<td>Albumin</td>
<td>66</td>
</tr>
<tr>
<td>3</td>
<td>Ammonium Glycyrrhizinate, Ampicillin trihydrate</td>
<td>Chitosan</td>
<td>67, 68</td>
</tr>
<tr>
<td>4</td>
<td>Copper sulphate</td>
<td>Zingiber officinale</td>
<td>69</td>
</tr>
<tr>
<td>5</td>
<td>Ibuprofen</td>
<td>Ethyl cellulose</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>Atorvastatin</td>
<td>Cyclodextrin</td>
<td>71</td>
</tr>
<tr>
<td>7</td>
<td>Cyclosporine A, Diclofen sodium, Carvedilol, Piroxicam</td>
<td>PLGA</td>
<td>72-75</td>
</tr>
<tr>
<td>8</td>
<td>Gold</td>
<td>Coriandrum sativum</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>Lanthanum</td>
<td>Gallatin</td>
<td>77</td>
</tr>
</tbody>
</table>

**Patents:** Some of the recent patents of nanoparticles and microspheres are illustrated below:

- Yaoliang Hong *et al.* [78] formulated expandable microsphere which were formed by the polymerization of suspension using a shot growth method. The microsphere consists of shell which consists of first polymer layer and second polymer layer. The first polymer layer is formed from primary monomer and second layer consist of chemically reactive monomer. Microspheres are formed by the polymerization of primary monomer, meanwhile the secondary monomer is added to the reaction vessels which is either a monomer or a chemical reactive monomer to continue the reaction process.
- Krishna K. Mohan *et al.* [79] investigated the composition, method of preparation of expandable microspheres. The invention also relates to one of the ionic compounds that has zeta potential greater than 1 or 0.
- David M. Lynn *et al.* [80] investigated dynamic charge state cationic polymer that was used for delivery of anionic molecules. was designed to have cationic charge densities that decreased by removal of functional groups from the polymer. The polymer present work inter poly electrolyte complexes containing the polymers complexes to delivered anionic compounds was also provided.
- Lian Leon Luo *et al.* [81] investigated compilation of polymer and medical devices useful for delivery system such as local or sustained delivery halo acetate (e.g. dichloro acetate) to the tissue. This type of method is useful for the treatment of disease such as cancer.
- Xavier Blin *et al.* [82] investigated cosmetic composition in which the organic liquid medium is cosmetically acceptable. The composition consists of non-volatile silicone oil and film former block of ethylene polymer. The composition was made up in such a way that it resumes as keratin material such as skin.
- Marcia Buiser *et al.* [83] was investigated embolic polymer partials was described. For example the particle included pores such that the predominant seized of pores near the canter of partials was greater than the predominant size of pores adjacent of periphery of the particles.
- Stephen E. Zale *et al.* [84] was investigated disclosure generally relit to therapeutic nanoparticles. Nanoparticles disclosed herein may included about 1 to about 20 weights present of vinika alkaloid and about 50 to 99 weight percent biocompatible polymer.
- Alexander Tseitlin *et al.* [85] investigated curable aqueous binder composition which includes dispersion of bio polymeric particle. Material used as follows mineral, natural, organic or synthetic, fiber products, mineral fiber insulation and glass fibbers products, wood based product and construction material, fiber glass insulation. Polymerization of resin when the biopolymer particle may be mixed in to formaldehyde based resin.
- Archie Eschborn *et al.* [86] has invented the air movement device which has polymer matrix and nanoparticles and the method for the manufacture of this device which has the dry mixing to form a dry mixture. The mixture was extruded to form a nanocomposite which was molded in the device. In this invention two embodiment has been used which mainly differ in percentage of the polymer formed by weight matrix polymer and weight layered clay.
- Igor Y. Denisyuk *et al.* [87] investigated method of preparing a nanocomposite that consist of a) non-alkali metal salt, a carboxylic acid compressed at least one aryl group b) provided a sulphide material c) first solution and sulphide materiel’s insulating the nanocomposite.
- Munir H. Nayfeh *et al.* [88] investigated that luminescent silicon nanoparticle polymer composite that can serve as UV absorber. The composition included a polymer an organosilicon compound and within the polymer or organ silicon compounds a
dispersion of luminescent silicon particles. A luminescent silicon wavelength convertor includes a composite film as described above for converting the narrowband wave length output in to wide band wave length output.

- Shlomo Marge et al. [89] investigated polymer that consist nanoparticle in which a metal chelating agent coated with a magnetic metal was used metal oxide. One active agent was covalently bound to the polymer so active agent physically bound to the outer surface of the magnetic metal oxide.

- Xiaorong Wang et al. [90] investigated controlled architecture of nano-necklace, nanocylinder, nano-ellipsoid or nanosphere. They also provided the method for preparing polymer nanoparticles and rubber article such as a tire manufacturing from the compressing formulation of the polymer nanoparticles.

- Dazhi Sun et al. [91] investigated the nanocomposites and nanoplatelets are formed from same method. Nanocomposite includes nanoparticulate polymer material and inorganic platelets and a polymer material.

- Fugang Li et al. [92] found when one agricultural active compound and polymer form nanoparticle then the size of nanoparticle was estimated to be less than 100 nm and that of polyelectrolyte polymer used.

- Jin-gyu Lee et al. [93] investigated that proton conducting group with inorganic nanoparticle bonded with a solid acid to form polymer electrolytes membrane. Protein conducting group bounded with inorganic nanoparticle may be obtained by reacting a compound including a metal precursor. It was observed that polymer electrolyte membrane has significantly enhanced proton conductivity and reduced methanol crossover.

- Jean-Philippe Caritey et al. [94] investigated shear gelling and shear thickening properties that was based on an amphiphilic polymer combined with polyethylene oxide with hydrophilic particles which consist of hydrous sodium lithium magnesium silicate. The amphiphilic polymer may be synthetic polymer modified bio polymer.

- Alexander V. Lublin et al. [95] investigated that solution polymerization and bulk polymerization technique used to form Vinyl polymers with nanoparticles to produce aqueous dispersions of nanoparticles/vinyl polymer composites.

- Diptabhas Sarkar et al. [96] has investigated that smart tags and use of nanoparticle smart tags in detection of analytic and subsurface geological formulation to detect analysis of interest in real-time. Drilling fluid in sub surface geologic formulation that had an analytic method.

- Edith Mathiowitz et al. [97] investigated bioactive substances or microsphere containing drug which may serve as therapeutic or diagnostic agent in disease related to gastrointestinal tract. Drug loaded microspheres and surface morphology act by bio adhesive forces on the other screening large group of synthetic or natural polymers that is used for making bio adhesive microsphere.

- Freddy Sanabria Scharf et al. [98] investigated a breast prosthesis constructed from a bag of elastic material or bio compatible mesh having a front face forming a dome and a rear face forming a base with a sealed and seam less interior cavity filled with microspheres of foam polymer or there to expend polymers or the combination of both.

**CONCLUSION**

Natural polymers like gums and mucilages have proved to be promising biodegradable polymeric materials. In pharmaceuticals, cosmetology as well as food industries many studies have been conducted which proves them to be more advantageous, less toxic and economical in comparison with the synthetic materials. Drug delivery systems like microspheres, nanoparticles, implants, transdermal, ocular systems etc prepared by natural polymers are the versatile carriers used these days. Modification in the existing natural materials will increase the ongoing interest in these agents for the preparation of novel drug delivery systems.

**Conflict of Interest:** Author has no conflict of interest.

**ACKNOWLEDGEMENT**

Authors would like to thanks department of Pharmacy, School of Medical and Allied Sciences, Galgotias university and NISCAIR (National Institute of Science Communication and information Resources), New Delhi for providing library facilities.

**REFERENCE**


