IJPSM

Deepak Sen *et al*, Int. Journal of Pharmaceutical Sciences and Medicine (IJPSM),
Vol.4 Issue. 10, October- 2019, pg. 1-15

ISSN: 2519-9889
Impact Factor: 3.426

REVIEW ON POLYMER

Deepak Sen*; Bhaskar Mohite; Dr. Nandu Kayande
THAKUR SHIVKUMAR SINGH MEMORIAL PHARMACY COLLEGE BURHANPUR (M.P)
Pharmadipak83@yahoo.com
Tel- +919754641339

ABSTRACT: Polymers are a large class of materials consisting of many small molecules. Polymers such as cotton, wool, rubber, Teflon(tm), and all plastics are used in nearly every industry. Evidence for the existence of cellulose comes from the close match of an infrared absorption spectrum of celestial origin with that of cellulose. The surface film is a pellicle of cellulose. In most elastic materials, such as metals used in springs, the elastic behavior is caused by bond distortions. In its relaxed state, rubber consists of long, coiled-up polymer chains that are interlinked at a few points. Polymeric delivery systems are mainly intended to achieve controlled or sustained drug delivery. Targeting of drugs to the colon following oral administration has also been accomplished by using polysaccharides. Polymeric materials have a vast potential for exciting new applications in the foreseeable future. Polymer uses are being developed in such diverse areas.
KEYWORDS: Polymer, Drug delivery system, Natural, cellulose.

1. INTRODUCTION

The word "polymer" means "many parts" (from the Greek poly, meaning "many," and mero, meaning "parts"). Polymers are giant molecules with molar masses ranging from thousands to millions. Approximately 80 percent of the organic chemical industry is devoted to the production of synthetic polymers, such as plastics, textiles fibers, and synthetic rubbers.

Polymers are a large class of materials consisting of many small molecules (called monomers) that can be linked together to form long chains, thus they are known as macromolecules. Humans have taken advantage of the versitility of polymers for centuries in the form of oils, tars, resins, and gums. However, it was not until the industrial revolution that the modern polymer industry began to develop. In the late 1830s, Charles Goodyear succeeded in producing a useful form of natural rubber through a process known as "vulcanization."[1]

ISSN: 2519-9889
Impact Factor: 3.426

First, cellulose is a natural biological photopolymer consisting of cellulose residues glycosidically linked in the (1 4)- configuration. Bundles of glucan chains associate via hydrogen bonding to form an insoluble ultramicroscopic thread known as the microfibril). These animals are chordates, and if one considers that multicellular animals of this evolutionary advancement have the capacity to synthesize cellulose, it is not inconceivable that mammals, including man, could also have this capacity.[2]

Starch is a member of the basic food group carbohydrates and is found in cereal grains and potatoes. It is also referred to as a polysaccharide, because it is a polymer of the monosaccharide glucose. Starch molecules include two types of glucose polymers, amylose and amylopectin, the latter being the major starch component in most plants, making up about three-fourths of the total starch in wheat flour. Amylase is a straight chain polymer with an average of about 200 glucose units per molecule.[3]

2. HISTORY

From 1811 Henri Braconnot did pioneering work in derivative cellulose compounds, perhaps the earliest important work in polymer science. The development of vulcanization later in the nineteenth century improved the durability of the natural polymer rubber, signifying the first popularized semi-synthetic polymer. In 1907 Leo Baekeland created the first completely synthetic polymer, Bakelite, by reacting phenol and formaldehyde at precisely controlled temperature and pressure. Bakelite was then publicly introduced in 1909.[4]

An important contribution to synthetic polymer science was made by the Italian chemist Giulio Natta and the German chemist Karl Ziegler, who won the Nobel Prize in Chemistry in 1963 for the development of the Ziegler-Natta catalyst. Further recognition of the importance of polymers came with the award of the Nobel Prize in Chemistry in 1974 to Paul Flory.

Deepak Sen *et al*, Int. Journal of Pharmaceutical Sciences and Medicine (IJPSM),
Vol.4 Issue. 10, October- 2019, pg. 1-15
ISSN: 2519-9889
Impact Factor: 3.426

People have been using artificial organic polymers for centuries in the form of waxes and shellacs. A plant polymer named "cellulose" provides the structural strength for natural fibers and ropes, and by the early 19th century natural rubber, tapped from rubber trees, was in widespread use of the polymer and granules of drug. [5]

Compared to untreated natural rubber, Goodyear's vulcanized rubber was stronger, more resistant to abrasion, more elastic, much less sensitive to temperature, impermeable to gases, and highly resistant to chemicals and electric current are the polymer and their substence.[6]

3. PROPERTIES

Polymer properties are broadly divided into several classes based on the scale at which the property is defined as well as upon its physical basis.The most basic property of a polymer is the identity of its constituent monomers. A second set of properties, known as microstructure, essentially describe the arrangement of these monomers within the polymer at the scale of a single chain.[7]

Chemical properties, at the nano-scale, describe how the chains interact through various physical forces. At the macro-scale, they describe how the bulk polymer interacts with other chemicals and solvents.[8,9]

3.1 Chemical Property

The attractive forces between polymer chains play a large part in determining a polymer's properties. Because polymer chains are so long, these inter chain forces are amplified far beyond the attractions between conventional molecules. The intermolecular forces in polymers can be affected by dipoles in the monomer units. Polymers containing amide or carbonyl groups can form hydrogen bonds between adjacent chains; the partially positively charged hydrogen atoms

ISSN: 2519-9889
Impact Factor: 3.426

in N-H groups of one chain are strongly attracted to the partially negatively charged oxygen atoms in C=O groups on another.

3.2 Mechanical properties

The bulk properties of a polymer are those most often of end-use interest. These are the properties that dictate how the polymer actually behaves on a macroscopic scale. The tensile strength of a material quantifies how much stress the material will endure before suffering permanent deformation.[10]

3.3 Transport Property

Transport properties such as diffusivity relate to how rapidly molecules move through the polymer matrix. These are very important in many applications of polymers for films and membranes. The term melting point, when applied to polymers, suggests not a solid-liquid phase transition but a transition from a crystalline or semi-crystalline phase to a solid amorphous phase.[11,12.]

3.4 Elasticity

In most elastic materials, such as metals used in springs, the elastic behavior is caused by bond distortions. When force is applied, bond lengths deviate from the (minimum energy) equilibrium and strain energy is stored electro statically.

IJPSM

Deepak Sen *et al*, Int. Journal of Pharmaceutical Sciences and Medicine (IJPSM),
Vol.4 Issue. 10, October- 2019, pg. 1-15

ISSN: 2519-9889
Impact Factor: 3.426

4. CLASSIFICATION

Natural polymers: The polymers obtained from nature (plants and animals) are called natural polymers. These polymers are very essential for life. They are as under.

(a) Starch: It is polymer of glucose and it is food reserve of plant.

Fig.4.1 Starch in Corn

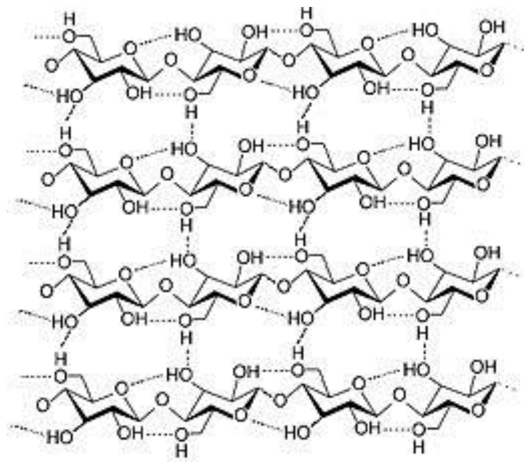
Plants are made of a polymer called cellulose. This is the tough stuff that wood and stems and Paul's tree house! - are made from. Cellulose is also what makes fibers like cotton and hemp that we can twist into threads and weave into clothing. And many plants also make starch. Potatoes, corn, rice, and grains all have a lot of starch. [13]

(b) Cellulose: It is also a polymer of glucose. It is a chief structural material of the plant both starch and cellulose are made by plants from glucose produced during photosynthesis. Cellulose is an organic compound with the formula $(C_6H_{10}O_5)_n$, a polysaccharide consisting of a linear chain of several hundred to over ten thousand β(1→4) linked D-glucose units.[14] Some bacteria can convert cellulose into ethanol which can then be used as a fuel; see cellulosic ethanol.

IJPSM

Deepak Sen *et al*, Int. Journal of Pharmaceutical Sciences and Medicine (IJPSM),
Vol.4 Issue. 10, October- 2019, pg. 1-15

ISSN: 2519-9889
Impact Factor: 3.426



(c) Proteins: These are polymers of α-amino acids, they have generally 20 to 1000 α amino acid joined together in a highly organized arrangement. These are building blocks of animal body and constitute an essential part of our food.[15]

d) Nucleic acids: These are polymers of various nucleotides. For example RNA and DNA are common nucleotides. It may be noted that polymers such as polysaccharides (starch, cellulose), proteins and nucleic acids etc. which control various life processes in plants and animals are also called biopolymers. Nucleic acids are linear polymers (chains) of nucleotides.[16]

Each nucleotide consists of three components: a purine or pyrimidine nucleobase (sometimes termed nitrogenous base or simply base), a pentose sugar, and a phosphate group.

(d) Silk: Another great protein is silk - a sort of fiber made by special caterpillars. This stuff has been used for thousands of years to make beautiful fabric for clothing. And though people have made their own version of silk called nylon, there's still nothing out there quite like silk.

(e) Enzymes: A special group of proteins that work inside the body are enzymes. Each enzyme is a specific little glob of a protein that does a specific job in the body, and does it really really

ISSN: 2519-9889
Impact Factor: 3.426

fast. Without enzymes, these jobs either just wouldn't happen, or would go way too slowly to make life possible! Some enzymes even make other enzymes.[17]

(f) Fibers: Fibers represent a very important application of polymeric materials, including many examples from the categories of plastics and elastomers.

5. APPLICATION [18]

5.1 PHARMACEUTICAL USES OF NATURAL POLYMER

5.1.1 Using Polymers in Drug Delivery

Natural-based polymers, biomimetic coatings, biodegradable scaffolds for tissue regeneration, naturally-derived hydrogels, sustainedrelease systems, and the biocompatibility of natural-based polymers.

5.1.2 Novel Colon Targeted Drug Delivery System Using Natural Polymers

A Novel Colon Targeted Tablet Formulation Was Developed Using Pectin As Carrier And Diltiazem Hcl And Indomethacin As Model Drugs. The Tablets Were Coated With Inulin Followed By Shellac And Were Evaluated For Average Weight, Hardness And Coat Thickness. In Vitro Release Studies For Prepared Tablets Were Carried Out For 2 H In Ph 1.2 Hcl Buffer, 3 H In Ph 7.4 Phosphate Buffer And 6 H In Simulated Colonic Fluid.

.1.3 Use of cellulose-

Polymeric delivery systems are mainly intended to achieve controlled or sustained drug delivery. Polysaccharides fabricated into hydrophilic matrices remain popular biomaterials for controlled-release dosage forms and the most abundant naturally occurring biopolymer is cellulose; so hdroxypropylmethyl cellulose, hydroxypropyl cellulose, microcrystalline cellulose

ISSN: 2519-9889
Impact Factor: 3.426

and hydroxyethyl cellulose can be used for production of time controlled delivery systems. Additionally microcrystalline cellulose, sodium carboxymethyl cellulose, hydroxypropylmethyl cellulose, hydroxyethyl cellulose as well as hydroxypropyl cellulose are used to coat tablets.26

5.1.4 Uses of chitosans

- **Opthalmic delivery**

Various studies showed the potential of chitosan-based systems for improving the retention and biodistribution of drugs applied topically onto the eye.

- **Nasal delivery**

The nasal mucosa presents an ideal site for bioadhesive drug delivery systems. Chitosan drug delivery systems, such as microspheres, liposomes, and gels, have been demonstrated to have good bioadhesive characteristics and swell easily when in contact with the nasal mucosa.

- **Buccal delivery**

Chitosan is an excellent polymer to be used for buccal delivery because it has muco/bioadhesive properties and can act as an absorption enhancer. Directly compressible bioadhesive tablets of ketoprofen containing chitosan and sodium alginate in the weight ratio 1:4 showed sustained release 3 hours after intraoral (sublingual site of rabbits) drug administration.

- **Gastrointestinal drug delivery**

Floating systems have a density lower than the density of the gastric juice. Thus, gastric residence time and hence the bioavailability of drugs that are absorbed in the upper part of the GI tract will be improved.

ISSN: 2519-9889
Impact Factor: 3.426

- **Intestinal drug delivery**

Sustained intestinal delivery of drugs, such as 5-fluorouracil (choice for colon carcinomas) and insulin (for diabetes mellitus), seems to be a feasible alternative to injection therapy.

- **Colon delivery**

Chitosan was used in oral drug formulations to provide sustained release of drugs. Recently, it was found that chitosan is degraded by the microflora that are available in the colon.

- **Vaginal delivery**

Chitosan, modified by the introduction of thioglycolic acid to the primary amino groups of the polymer, embeds clotrimazole, an imidazole derivative widely used for the treatment of mycotic infections of the genitourinary tract.

- **Transdermal delivery**

Chitosan has good film-forming properties. The drug release from the devices are affected by the membrane thickness and cross-linking of the film. Chitosan-alginate poly electrolyte complex (PEC) has been prepared in situ in beads and microspheres for potential applications in packaging, controlled release systems, and wound dressings. [19]

ISSN: 2519-9889
Impact Factor: 3.426

5.2 INDUSTRIAL APPLICATION[20]

5.2.1 Use of Guar Gum

- **Guar Gum for Pharmaceutical Industries**

Guar gum powder is used in pharmaceutical industries as Gelling/ Viscosifying/Thickening, Suspension, Stabilization, Emulsification, Preservation, Water Retention/Water Phase control, Binding, Clouding/Bodying, Process aid, Pour control for following applications.

- **Guar Gum for Cosmetic Industries**

- Used as a thickener, protective colloid in Skin care products, creams and lotions.
- Also used in toothpaste, and shaving cream for easy extruding from the container tube.

- **Industrial Grade Guar Gum Powder**

In Industrial Applications guar gum powder is a very versatile product and finds its different applications, as thickening, sizing agent, wet-end strength additive, gelling agent and water barrier, flocculation aid, for waste water treatment, as emulsifier, binder.

- **Guar Gum for Paper Industry**

- Guar Gum provides better properties compared to substitutes.
- It gives denser surface to the paper used for printing.

- **Guar Gum for Textile Industry**

- Guar Gum gives excellent film forming and thickening properties when used for textile sizing, finishing and printing.

ISSN: 2519-9889
Impact Factor: 3.426

- It reduces warp breakage, reduces dusting while sizing and gives better efficiency in production.

- **Guar Gum in Oil Field Applications**

- Industrial grade Guar gum powder are use in oil well fracturing, oil well stimulation, mud drilling and industrial applications and preparations as a stabilizer, thickener and suspending agent.
- It is a natural, fast hydrating dispersible guar gum and is diesel slurriable.
- In the oil field industry, guar gum is used as a surfactant, synthetic polymer and deformer ideally suited for all rheological requirements of water-based and brine-based drilling fluids.

5.2.2 FIBERS:

- Fibers represent a very important application of polymeric materials, including many examples from the categories of plastics and elastomers.Natural fibers such as cotton, wool, and silk have been used by humans for many centuries. In 1885, artificial silk was patented and launched the modern fiber industry.[21]

5.2.3 TEXTILE APPLICATION:

- Additionally, rubber produced as a fiber sometimes called elastic, has significant value for use in the textile industry because of its excellent elongation and recovery properties. For these purposes, manufactured rubber fiber is made as either an extruded round fiber or rectangular fibers that are cut into strips from extruded film.

IJPSM

Deepak Sen *et al*, Int. Journal of Pharmaceutical Sciences and Medicine (IJPSM),
Vol.4 Issue. 10, October- 2019, pg. 1-15

ISSN: 2519-9889
Impact Factor: 3.426

5.2.4 BODY DEVELOPMENT:

You know they say "You are what you eat." Well, one natural polymer that we eat a lot of is also one we are made of - PROTEIN!

- **5.2.5 USE OF RUBBER:**

The use of rubber is widespread, ranging from household to industrial products, entering the production stream at the intermediate stage or as final products. Tires and tubes are the largest consumers of rubber. The remaining 44% are taken up by the general rubber goods (GRG) sector, which includes all products except tires and tubes.[22]

5.2.6 PAINTING AND ART:

Powdered gum arabic for artists, one part gum arabic is dissolved in four parts distilled water to make a liquid suitable for adding to pigments.A selection of gouaches containing gum Arabic Acacia gum (gum arabic) is used as a binder for watercolor painting because it dissolves easily in water. Pigment of any color is suspended within the acacia gum in varying amounts, resulting in watercolor paint.

5.2.7 Papermaking:

Paper_making is the largest non-food application for starches globally, consuming millions of metric tons annually .In a typical sheet of copy paper for instance, the starch content may be as high as 8%. Both chemically modified and unmodified starches are used in papermaking.

ISSN: 2519-9889
Impact Factor: 3.426

5.2.8 Corrugated board adhesives:

Corrugated board adhesives are the next largest application of non-food starches globally. Starch glues are mostly based on unmodified native starches, plus some additive such as borax and caustic soda. Part of the starch is gelatinized to carry the slurry of uncooked starches and prevent sedimentation.[18]

5.2.9 Clothing starch:

Clothing or laundry starch is a liquid that is prepared by mixing a vegetable starch in water (earlier preparations also had to be boiled), and is used in the laundering of clothes. Starch was widely used in Europe in the 16th and 17th centuries to stiffen the wide collars and ruffs of fine linen which surrounded the necks of the well-to-do.[23]

6. CONCLUSION

Just as nature has used biological polymers as the material of choice, mankind will chose polymeric materials as the choice material. Humans have progressed from the Stone Age, through the Bronze, Iron, and Steel Ages into its current age, the Age of Polymers. An age in which synthetic polymers are and will be the material of choice.

The large number of current and future applications of polymeric materials has created a great national need for persons specifically trained to carry out research and development in polymer science and engineering. A person choosing a career in this field can expect to achieve both financial reward and personal fulfillment.

ISSN: 2519-9889
Impact Factor: 3.426

REFERENCES

1. Brown, W. H.; Poon, T. "Introduction to organic chemistry" 3rd ed 2005.
2. Abdul-Bari, H.A. and R.B.M. Yunus, 2009. "Drag reduction improvement in two phase flow system using traces of SLES surfactant".
3. Rouge N, Buri P, Doelker E. "Drug absorption sites in the gastrointestinal tract and dosage forms for site specific delivery". Int J Pharm. 1996; 136: 117-139.
4. Bari, H.A.A., E. Suali and Z. Hassan, 2008. "Glycolic acid ethoxylate lauryl ether performance as drag reducing agent in aqueous media flow in pipelines".
5. Al-Sarkhi, A., 2010. "Drag reduction with polymers in gas-liquid/liquid-liquid flows in pipes".
6. Singh BN and Kim KH. "Floating drug delivery systems: an approach to oral controlled drug delivery via gastric retention." J. Control.
7. Gjullin CM. "Effect of clothing color on the rate of attack of Aedes mosquitoes". J Econ Entomol. 1947; 40:326-7.G
8. Gillies MT. "The role of carbon dioxide in host-finding by mosquitoes (Diptera: Culicidae)" a review. Bulletin of Entomological Research. 1980; 70:525-32.
9. Gillies MT, Wilkes TJ. "The range of attraction of animal baits and carbon dioxide for mosquitoes." Studies in a freshwater area of West Africa. Bulletin of Entomological Research. 1972; 61:389-404.
10. N. C. Carpita, "Demonstration of Cellulose Synthesis in Detached Cotton Fibers," presented at 176th ACS National Meeting (Cellulose, Paper and Textile Chemistry Division), Miami, Florida, 1978.
11. K. Muhlethaler, Biochim. Biophys. Acta, 3, 527 (1949).
12. A. Forge, Ann. Bot., 41, 447 (1977).
13. R. M. Brown, Jr., J. H. M. Willison, and C. L. Richardson, Proc. NatI. Acad. Sci. U.S.A., 73, 4565 (1976).
14. Van Holde KE, Mathews CK (1996). Biochemistry. Menlo Park, California: Benjamin/Cummings Pub. Co., Inc.
15. Schwarzer D, Cole P (2005). "Protein semisynthesis and expressed protein ligation: chasing a protein's tail". Current Opinions in Chemical Biology **9** (6): 561–69.
16. Bruckdorfer T, Marder O, Albericio F (2004). "From production of peptides in milligram amounts for research to multi-tons quantities for drugs of the future". Current Pharmaceutical Biotechnology **5** (1): 29–43.
17. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipurksy SL, Darnell J (2004). Molecular Cell Biology (5th ed.). New York, New York: WH Freeman and Company.
18. Nelson DL, Cox MM (2005). Lehninger's "Principles of Biochemistry" (4th ed.). New York, New York: W. H. Freeman and Company.

ISSN: 2519-9889
Impact Factor: 3.426

19. Cunningham, Scott (1989). "The Complete Book of Incense, Oils, and Brews". Woodbury, MN: Llewellyn Publications. pp. 49.
20. Davidson, Alan, and Tom Jaine. "The Oxford companion to food". Oxford University Press, USA, 2006. 805. Print. Retrieved Aug. 08, 2010, from
21. Williams, Peter W.; Phillips, Glyn O. (2000). "Handbook of hydrocolloids". Cambridge: Woodhead.
22. Balfour, Edward. (1885). "The cyclopædia of India and of eastern and southern Asia: commercial, industrial and scientific, products of the mineral, vegetable, and animal kingdoms, useful arts and manufactures". B. Quaritch. p. 71.
23. Dahm, R (Jan 2008). "Discovering DNA: Friedrich Miescher and the early years of nucleic acid research". Human genetics **122.**

