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ETHYL CELLULOSE AND ZEIN: A MINI REVIEW

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ABSTRACT

Properties of dilute solution of ethyl cellulose (EC) such as intrinsic viscosity and interaction constant helps in determining solvent systems for coating processes. Methylene chloride and Ethanol (60/40%w/w) was effective solvent system and further addition of water up to 10% was advantageous for such system. However, if water is present in high concentration in film coating system it would evaporate at low rate and cause precipitation of polymer which results in low mechanical strength of ethyl cellulose film. This paper provides a comprehensive review on various Physicomechanical properties of EC as important tool for coating process. Studies on co-interaction with chitosan and some protective effect of vitamins (Folic acid, tocopherol & cholecalciferol) are highlighted. Futuristic approach of zein as an alternative substitute for fast disintegrating film coatings is also been suggested.

INTRODUCTION

Sustain Release of active pharmaceutical ingredient is obtained by using polymers. Polymer containing formulation consists of use of solvents i.e. solvents for coating. Ethyl cellulose acts as good film former and matrix forming agent. Ethyl cellulose is a derivative of **cellulose** in which the hydroxyl groups on the repeating glucose units are converted into ethyl ether groups. The number of ethyl groups can vary depending on the manufacturer. It is mainly used as a thin-film coating material. Ethyl cellulose is used as a food additive as an emulsifier [1], thickening agent in creams, lotions or gels [2] and stabilizer for emulsions [3].

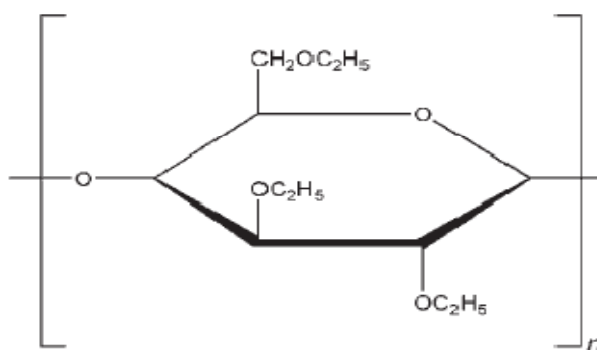


Figure 1 Chemical Structure of ethyl Cellulose

PHYSICOCHEMICAL PROPERTIES OF ETHYL CELLULOSE AFFECTING FILM COATING PROCESS

Intrinsic viscosity [4]

It is important tool for selection of solvent in case of ethyl cellulose. Intrinsic viscosity is ability of solvent to swell polymer (depends upon the molecular weight). High value of intrinsic viscosity means existence of polymer as loose coils in solution and low value means polymer is present as tight coils. Thus, polymers films made from solvent having high intrinsic viscosity are mechanically strong.

Interaction constant [4]

Interaction constant indicates the interaction between polymer molecules in solution independently of molecular weight. It reflects interaction resulting solely from difference in chemical structure of polymer or nature of solvent system. A good solvent have following characteristics:

- Good solvent should have low value of interaction constant with the polymer.

- Polymer with solvent of low interaction constant value reaches gel point at more concentration.
- Gelation at higher concentration levels reduces internal stress in the film which implies low value of interaction constant favours mechanical properties of film.
- A solvent system containing poor hydrogen bonding solvent and strongly hydrogen bonding solvent (e.g. methylene chloride and ethanol 60:40 %w/w), toluene and ethanol (80:20 % w/w) are favourable for ethyl cellulose.

Particle size [5-8]

Particle size yields a great impact on properties of ethyl cellulose. Slower drug release rates were observed with small particle size of ethyl cellulose. According to percolation theory, when matrix containing water soluble drugs and water insoluble polymer, drug release is due to dissolution of active pharmaceutical ingredient through capillaries at the junction of drug particles. As drug releases the junction increases the pore network by which intrinsic drug can diffuse. The number of ethyl cellulose particles increases as its particle size is reduced, which concludes that fewer soluble drug clusters are formed. As a result pore network become more tortuous resulting in slow drug release.

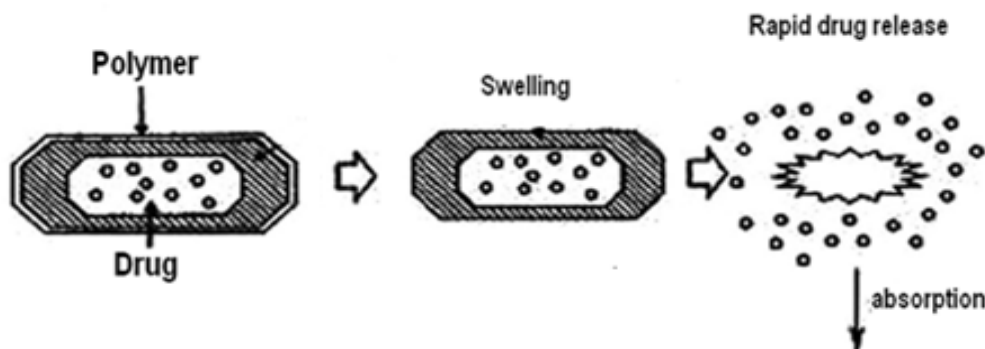


Figure 2 Release of drug on polymer swelling

TABLETTING TECHNIQUE

Drug release rates were found to be slower in tablets formed by hot melt extrusion technique. This is mainly due to lower porosity and higher tortuosity. During hot melt extrusion solid bridges between drug and polymers are formed upon cooling. On cooling drug molecules remain dispersed in these bridges or domains. This resulted in increase degree of packing and reduction in free volume due to exclusion of air from powder bed.

COMPACTION FORCE

Drug release rate decreases with increasing compaction force. At higher compaction, pressure powder bed show intense densification due to elimination of air with reduction of voids in individual particles.

IMPROVEMENT IN PROPERTIES OF CHITOSAN WITH ETHYL CELLULOSE MICROSPHERES [9]

Chitosan exhibits antimicrobial, biodegradable and biocompatibility properties. Chitin is most abundant polysaccharide which shows protonation under acidic conditions and also has excellent film forming property. When ethyl cellulose microspheres were put in chitosan film they become major drug carrier when compared to chitosan matrix and impart hydrophobicity to the film, hence it was hard for liquid to enter the film. Combination of chitosan with ethyl cellulose in microspheres help in achieving better release property for hydrophilic drugs which was difficult to achieve previously specially in extended release.

PROTECTIVE EFFECT ON OILY VITAMINS [10]

Ethyl cellulose networks have great compatibility for oil soluble vitamins which project higher factors of safety, greater strength and toughness. Thus ethyl cellulose provides protection against oxidative degradation of lipophilic vitamins like cholecalciferol, tocopherol and folic acid. Further use of Span 80 decreases average diameter of microcapsule and thereby increases rate of drug release.

ASSOCIATION WITH ANIONIC SURFACTANTS [11]

Previously a lot of research has been done on amphilic systems and micelle formation mechanisms along with surfactant / polymer interaction. But most of studies deal with concentrated solutions.

- Interactions of proteins and water soluble polymers are mainly monitored by surface tension and specific conductivity.
- The presence of excess monomers of surfactant provides a useful measure of effectiveness of adsorption of surfactant.
- Conductivity is used to estimate the degree of ionization of ionic micelles and helps in studying association process of micelles of ionic surfactants and mixture of water solubilised neutral polymer.

ZEIN AN ALTERNATIVE SUBSTITUTE [12]

Zein (protein in endosperm of zea mais) might serve as an inexpensive and most effective substitute for the fast disintegrating synthetic and semi synthetic film coatings. This property might be due to the following reasons:

- Due to the presence of hydrophobic amino acids and chemically unmodified polysaccharides, in abundance, zein show less water uptake compared to other proteins (e.g. casein or gelatin).
- Density, compressibility and thermal expansivity values for zein matches with expected for ethyl cellulose.

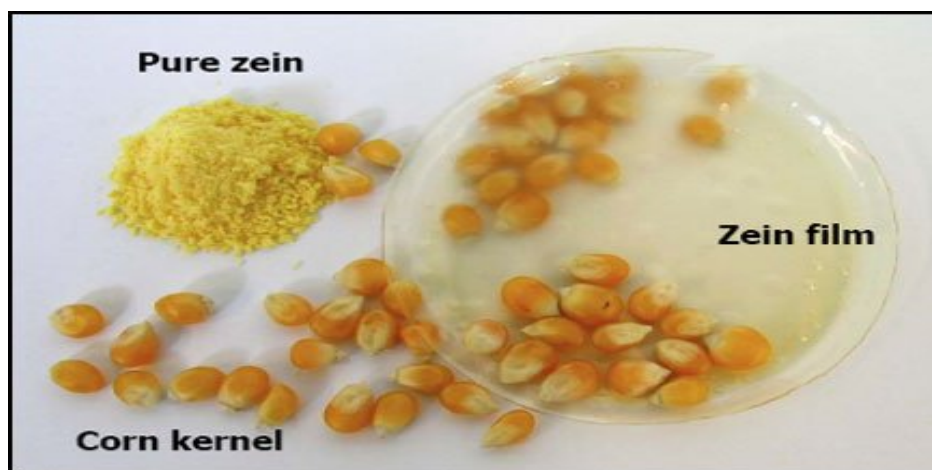


Figure 3 Representation of Zein (Pure and Film)

- The cohesive properties and water sorption properties of zein are comparable to that of ethyl cellulose.
- Zein provide very good resistance to oxygen permeation hence it is useful for protecting encapsulated ingredients of solid dosage forms from oxidative degradation.
- Due to low glass transition temperature it has good mechanical properties and thus contributes good mechanical strength to coating films.
- Compression moulded samples provide data about actual Tg depression of zein by different plasticizing compounds.

CONCLUSION

Ethyl cellulose is a water insoluble, non biodegradable, biocompatible and non toxic cellulose polymer widely used in formulation of pharmaceutical products. Physicochemical properties like intrinsic viscosity, interaction constant etc help in determining the solvent system for coating processes. Interaction of ethyl cellulose with Chitosan aid in sustains release of various Active

Pharmaceutical Ingredients. Moreover, the microspheres of ethyl cellulose with various drugs can also be prepared imparting good controlled release. Ethyl cellulose showed protective effect on vitamins like folic acid and cholecalciferol by preventing their oxidative degradation. Interestingly Zein provides an inexpensive and effective substitute for fast disintegrating film coatings.

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