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A Review of Different Polymer and Plasticizers

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Abstract

Plasticizer and polymer are essential components in the pharmaceutical industry, especially when creating both cutting-edge and conventional drug delivery systems. The differences between synthetic, semi-synthetic, and all-natural polymers are examined in this review to highlight their diverse qualities and uses. When designing drug delivery systems to target areas, the choice of polymer is crucial. Because of their repeatability and adaptability, synthetic polymers are widely used in the creation of precision medication delivery systems. Certain polymers, such poly (lactic-co-glycolic acid) (PLGA) and polyethylene glycol (PEG), are well-known for their tunable characteristics and biocompatibility, which makes them appropriate for targeted drug release. Semi-synthetic polymers, on the other hand, provide a medium between regulated drug release and biodegradability, bridging the gap between natural and fully synthetic materials. This class of cellulose derivatives includes, for example, hydroxypropyl methylcellulose (HPMC), which is helpful in the formulation of medications with a variety of release characteristics. Plasticizers are an essential component that is used for coating tablets and maintaining medication release. They ensure the best possible medication delivery by improving the polymeric coatings' flexibility and durability. Common plasticizers that affect the final dosage form's mechanical and release qualities are triethyl citrate (TEC) and dibutyl phthalate (DBP). The usage of polymers and plasticizers has several disadvantages notwithstanding their benefits. Drug stability or efficacy may be changed by interactions between polymers and pharmaceuticals. Furthermore, some plasticizers may show signs of toxicity, which means that pharmaceutical formulations must undergo careful testing and adhere to regulations. The discovery of novel pharmacological remedies is the aim of this comprehensive study. Through clarifying the fundamental properties of polymers, classifying different kinds, and describing the roles of plasticizers, scientists may better customise drug delivery systems. The assessment highlights the significance of giving considerable thought and optimisation to reduce harmful effects while addressing potential issues.

Keywords: Polymer, plasticizers, natural, synthetic, PVP, GA

INTRODUCTION OF POLYMER

Polymer: The polymers utilised in film coating are either copolymers and acrylic polymers, or cellulose derivatives such cellulose ethers. Polyvinyl alcohol, polyethylene glycols with high molecular weight, and waxy compounds. Before applying the coating on the solid dosage form, the polymer is dissolved in the proper solvent, which can be either water or a non-aqueous solvent [1].

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CLASSIFICATION OF POLYMERS

Synthetic polymers

a. Poly (acrylic acid) polymers (carbomers,polycarbophil).
b. Cellulose derivatives (MC, EC, HPMC, Sodium CMC).
c. Poly (hydroxyethylmethylacrylate).
d. Poly (ethylene oxide).

e. Poly (vinyl pyrrolidone).
f. Poly (vinyl alcohol).

Natural polymers

a. Guar gum Xanthan gum
b. Lectin
c. Soluble starch
d. Tragacanth
e. Sodium alginate
f. Karaya gum
g. Gelatin
h. Pectin
i. Chitosan

BIOADHESIVE POLYMER

These materials fall into two categories based on how they were prepared: real latexes and pseudo latexes [2].

Classification of Bioadhesive Polymer

Polymers, whether natural or synthetic, make up a large number of bioadhesives. The majority of artificial bioadhesive polymers are cellulose or polyacrylic acid derivatives. Poly (methylvinylether-co-methacrylic) acid, polyacrylic acid (PAA), polyacrylate, carbopol, polycarbophill, and poly (methacrylate) are a few examples of polymers based on polyacrylic acid. Among the cellulosic materials are methylcellulose, carboxy methylcellulose, sodium carboxy methylcellulose, and hydroxypropyl methylcellulose. Furthermore, guar, xanthenes, pectin, and force at the contact are among the gums and other (semi) natural bioadhesive polymers that comprise CH. The reason a bioadhesive may adhere to a hydrophobic substrate more firmly than a hydrophilic surface, on the other hand, can be explained by hydrophobic interactions.

True latexes

The stability and use of these materials depend greatly on the particle size, which is present in these extremely thin polymer dispersions in an aqueous phase. Their particle sizes range from 10 to 1000 nm, which defines them [3]. Their propensity to settle is opposite to that of;

- Plasticizers
- Polymers
- Vehicle
- Pigment/opacifier

Method

The inclusion of an initiator causes the polymerization to begin. The initiator regulates the pace and magnitude of the reaction during the polymerization process. When the particles are between 50 and 200 nm in size, the process is quenched. Eudragit L100–55 and NE30D, two acrylate polymers, are made using this technique (Lehmann, 1989a).

Psuedolatexes

There are two main commercial products that fit into this category; they both use polyethylcellulose as the film former, but they are made relatively differently, and they also apply differently. Pseudolatexes are typically made starting with the polymer rather than the monomer [4]. Additionally, there are no remnants of monomer, initiator, etc. in the pseudolatex.

SOLUBILITY OF POLYMER [5]

Solubility of different polymer is shown in Table 1.

Table 1. Solubility of different polymer.

Full name	Abbreviation	Solubility	Comments
Non enteric materials			
Methyl cellulose	MC	Cold water, GI fluid, organic solvents.	Useful polymer for aqueous film, low viscosity grade best.
Ethyl cellulose	ES	Ethanol, other organic solvents.	Cannot be used alone as is totally insoluble in water and GI fluids, employed as a film toughner
Hydroxyethyl cellulose	HEC	Water and GI fluids	Properties similar to MC, but gives clear solutions.
Methyl hydroxyl ethyl cellulose	MHEC	GI fluids	Similar Properties to HPMC, but less soluble in organic system
Hydroxypropyl cellulose	HPC	Cold water, GI fluid organics such as anhydrous lower alcohol	Difficulty in handling due to tackiness while drying.
Hydroxypropylmethylcellulose	HPMC	Cold water, GI fluid, methanol/methylene chloride, alcohol, flurohydrocarbons.	Excellent film former and readily soluble throughout GIT, low viscosity grade to be preffered, eg..methocel HG(dow)
Sodium carboxy methyl cellulose	Na-CMC	Water and polar organic solvent.	Main use where presence of solvent is not a problem.
Povidone	PVP	Water, GI fluid, alcohol and IPA	Care indeed in use due to tackiness during drying, best used use in mixture due to adhesion is hydroscopic if use alone.
Polyethylene	PEGs	Water GI fluid and some organic solvents	Low molecular weight grades used mainly as film former, particularly plasticizers.
Enteric materials			
Shellac		Aqueous if PH & 7.0	May delay release too long, high batch to batch variability.
Cellulose acetate	CAP	Acetone, ethyle acetate/IPA, alkalies, if pH 6.0	Dissolve in distal end of duodenum, requires presence of plasticizer such as triacetin or castor oil, is somewhat hygroscopic.
Polyvinyl acetate phthalate		As above pH, >4.5	Dissolves along whole length of duodenum
Hydroxypropylmethyl cellulosepthalate	PVAP	As above pH, >5.0	Dissolves in proximal end of duodenum
Polymethacrylate	(HPMCP)	Eudragit L pH>6 Eudragit S pH>7	Solublized in alkali media, mixtures of “L” and “S” can provide enteric coating plus enteric release.

SELECTION OF POLYMER [6]:

1. Polymer stability in acidic environment with desired bouncy.
2. It dissolves slowly enough to serve predictable release rate.

We are discussing some polymers properties which are following below:

Povidone

The linear 1-vinyl-2-pyrrolidinone group makes up this artificial polymer. Povidone is often offered in four grades, which are roughly K-15, K-30, K-60, and K-90, denoted by their K values. These classes have respective average molecular weights of 10,000, 40,000, 160,000, and 360,000. Povidone is mostly used as a tablet coating and tablet binder in pharmaceuticals (often K-30). It dissolves very

well in water as well as in intestinal and stomach fluids. Povidone can form films with enteric qualities by cross-linking with other materials. It is soluble in both basic and acidic fluids [6-7].

Methyl Hydroxyethylcellulose

To make this polymer, methyl-cellulose and ethylene oxide are first reacted with alkali-treated cellulose. There is a large range of viscosity grades available. This polymer is predicted to have qualities similar to hydroxypropyl methylcellulose due to its structural similarities. Although it is not as commonly utilised as hydroxypropyl methylcellulose, it is soluble in fewer organic solvents.

Hydroxypropyl Cellulose, FCC

This material is made by first treating cellulose with sodium hydroxide, then reacting at high pressure and temperature with propylene oxide. It dissolves in gastrointestinal fluids, several polar organic solvents, and water at temperatures below 40°C (it becomes soluble at 45°C). Flexible films are produced by polymer. To enhance the qualities of the film, it is typically used in conjunction with other polymers rather than by itself [7].

Hydroxypropyl Methylcellulose, USP

For pan-spray coating systems and air suspension systems, the polymer is the preferred material. Its widespread acceptance can be attributed to the following factors:

- Properties of the polymer's solubility in organic and aqueous solvent systems, as well as in gastrointestinal fluid
- Non-interference with medication availability and tablet breakdown.
- Flexibility, resistance to chips, and lack of flavour or odour.
- Stability in the presence of appropriate moisture levels, heat, light, and air.
- The film's ability to easily incorporate colour and other additives.

Polymer contact is uncommon. Hydroxypropylmethylcellulose comes very near to having the qualities that make a perfect polymer for thin coating. To get rid of bridging or filling issues, hydroxypropyl methyl cellulose is mixed with other polymers or plasticizers. Glossing solution also makes extensive use of this polymer.

Sodium carboxymethyl cellulose, USP

This material is a sodium salt of carboxymethylecellulose and is manufactured by the reaction of soda cellulose with the sodium salts of monochoroacetic acid. It is available in low medium and high viscosity grades. It is easily dispersed in water to form colloidal solutions, but it is insoluble in most of the organic solvents. Films prepared with sodium methyl cellulose. Film prepared by sodium carboxymethyle cellulose is brittle, but adhee well to tablets. Conversion to aqueous based film coating with high coating efficiency equipment probably increases the usefulness of this polymer in coating system [8].

Acrylate polymer

Eudrazit is the trademark used to promote a variety of acrylate polymers. Only eudrazit E is readily soluble in stomach fluid up to pH and expandable and permeable above pH. It is a cationic copolymer based on dimethylaminoethyl methacrylate and other neutral methacrylic acid esters. This material is available as:

- Organic solution (12.5%) in isopropanol/acetone
- Solid material
- 30% of aqueous dispersion.

Made from acrylic and methacrylic acid esters, Eudragit RL and SL copolymers have a low quaternary ammonium group concentration. Similar to ethyl cellulose formulations, these polymers created a film for delayed action preparation [8-9].

Cellulose acetate phthalate

Originally invented as an enteric agent by Eastman Kodak in 1940, this synthetic coating polymer is the oldest and most commonly utilised. Phthalic anhydride and a partial acetate ester of cellulose are reacted to create it. Of the free hydroxyl groups that are provided by each glucose unit of the cellulose chain in the resultant polymer, around half are acylated, and the remaining 25% are esterified with one of the two carboxylic acid groups of the phthalate moiety. The foundation of its enteric feature is the second carboxylic acid group, which is free to produce salts [9].

CAP is a free-flowing, white powder that typically has a faint acetic acid smell.

The USNF specifies 21.5–26 and 30–36% for acetyl and phthalyl concentration, respectively, while the JP demands 17–22 and 30–40%, respectively. In terms of not requiring any viscosity control on a standard solution, the JP is unique. Each of the three pharmacopoeias has a maximum restriction on the amount of free acid (JP specifies phthalic acid) and water content (EP specifies loss on drying). Given that CAP is relatively prone to hydrolysis, the latter two values are crucial. CAP is insoluble in water, alcohols, and chlorinated hydrocarbons among the commonly used solvents for tablet coating. The simplicity of aqueous-based processing is provided by the Aquateric pseudo latex version of CAP, which is available as a dry powder for reconstitution in water.

Ethylcellulose

Ethyl chloride reacts with the proper alkaline cellulose solution to form ethylcellulose, a cellulose ether. Ethylcellulose is widely used in controlled release coatings, but it is also used in organic solvent-based coatings when combined with other cellulosic polymers, most notably HPMC. By reducing surface marking from handling, the ethylcellulose component maximises film durability. Additionally, ethylcellulose gives the tablet surface more lustre and gloss [10]. Ethylcellulose is a perfect polymer for modified release coatings in several aspects. It is tasteless and odourless, and it has a high degree of stability under physiological conditions as well as typical storage settings. It is stable against light and heat up to around 135°C, which is its softening point (Rowe, 1985). Ethylcellulose can be purchased commercially in a variety of viscosity and replacement kinds, providing formulators with a good number of options. It also has good solubility in typical solvents used for film coating, but this characteristic is becoming less significant with the introduction of ethylcellulose compositions that dissolve in water and are specifically made for modified release coatings. Instead of being employed alone, the polymer is typically combined with secondary polymers like polyethylene glycols or HPMC, which give the film a more hydrophilic quality by changing its structure and adding pores and channels that make it easier for medication solutions to diffuse through. The only monograph available is the USNF, which specifies an ethoxy group concentration of 44.0–51.0%.

Another resource that is useful in aqueous processing is the monograph "Ethylcellulose Aqueous Dispersion" that is contained in the USNF. Because it is required to stabilise the dispersion, the monograph allows the use of sodium lauryl sulphate and cetyl alcohol [9-10].

Polyvinyl acetate phthalate (PVAP)

PVAP was initially developed by the Canadian company Charles E. Frost. Millar (1957) then looked into the impact of the polymer's phthalyl concentration on the pH at which the material-coated tablets disintegrated. According to his findings, phthalyl concentration should be between 60 and 70%. It is produced by reacting polyvinyl alcohol with phthalic anhydride and acetic acid. A monograph in the USNF stipulates that the overall phthalate content should be between 55 and 62%. The application of a viscosity specification further regulates the properties of the polymer. A limit on free phthalic acid and other free acids regulates the amount of hydrolysis, even though it is far less frequent than with CAP, for example. A 5% water restriction is specified since the final separation

procedure is from water. With the degree of solubility indicated in parenthesis, polyvinyl acetate phthalate is soluble in methanol (50%), methanol/methylene chloride (30%), ethanol 95% (25%), and ethanol/water 85:15 (30%). For water-based spraying, there is an aqueous dispersible version called Sureteric [11].

INTRODUCTION OF PLASTICIZER

All plasticizers are are low molecular weight substances that can change a polymer's physical characteristics to make it better suited for its intended application as a film-coating material. A polymer and its plasticizer frequently share chemical properties. For example, glycerol and propylene glycol, which are plasticizers for a number of cellulosic systems, share —OH groups with the polymer [12].

CLASSIFICATION OF PLASTICIZERS [13]

Some of the commonly plasticizers are shown in Figure 1:

a. Castor oil
b. Propylene glycol
c. Glycerin low-molecular weight,
d. Propylene gycols of 200 and 400 series and
e. Surfactants, e.g., Polysorbate (tween), sorbitan esters (spans)and organic acid esters.

Selection of plasticizers depends on

a. The ability of plasticizer material to solvate the polymer.
b. Alter their polymer-polymer interaction

With the increasing interest in aqueous coating, water soluble plasticizers, e.g., polyethylene glycol and propylene glycol is used [13]. A combination of plasticizers may be needed to achieve the desired effect.

The concentration of plasticizers depends on many factors:

- Includes polymer chemistry
- Method of application
- And component present on the system

MAIN FUNCTION S PERFORMED BY PLASTICIZERS [14-15]

Main Functions Performed by Plasticizers with Coalescing Agent

Following functions are performed by plasticizers and coalescing agents in acrylic resins:

- coalescing (film forming properties, mechanical properties improvement)
- decrease of glass transition temperature (improved elongation, elasticity, low temperature curing)
- control migration rate of drug (controlled-release properties)
- adhesion promotion (softening surface of polymer coated by surface layers)

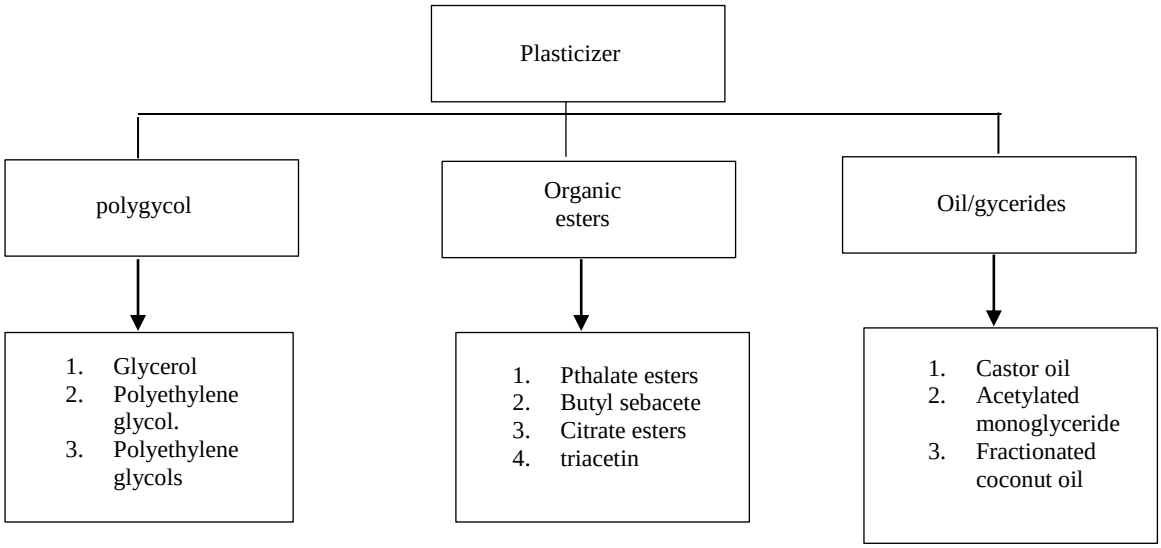

Figure 1. Classification of plasticizers.

Main functions Performed by Plasticizers

The following functions are performed by plasticizers:

- Reducing material hardness and other mechanical properties such as tensile strength, tensile modulus, flexuralstrength, flexural modulus.
- Reducing glass transition temperature32
- Influencing diffusion coefficient of liquids and gases permeating through membranes.
- Imparting flame retarding properties (phosphates)
- Permanent coalescing agent and solvent
- Fiber-to-fiber bonding agent
- Shortening the drying process in solvent-containing processes by reducing the amount of solvent required.

CONCLUSION

All these polymer and plasticizers used in different type of coating, which affects their physiochemical properties. Hydroxyl polymethyl cellulose is widely used because their interactions are rare and form a thin coat which closely approach to ideal polymer. We can also add a drug to polymer and platicizers which are studied laters. Future uses of polymer and plasticizers their interaction. To study drug polymer interactionDrug plasticizer interaction.

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