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(RESEARCH ARTICLE)

Carbopol 71G-NF polymer –The next pillar of oral solid dosage form

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Abstract

For pharmaceutical Oral Solid Dosage Form (OSDF) there are lots of excipients used and these excipients influence the drug release. In the recent decades there has been considerable interest in using carbopol polymers as excipients in a distinctive range of pharmaceutical application. Carbopol polymers are high molecular weight, cross linked, acrylic, acid-based polymers. Carbopol homopolymers are polymers of acrylic acid cross linked with ally sucrose or allylPentaerythritol. These polymers are offered as fluffy, white, dry powders. The carboxyl groups provided by the acrylic acid backbone of the polymer are responsible for many of the product benefits. This review work aims at guesstimate the characteristic of Carbopol 71G-NF polymer to be used as excipients in oral solid dosage form (OSDF).

Keywords: Carbopol polymer; Types 71G-NF; Applications

1. Introduction

Carbopol polymers were first discussed in 1955 scientific campaign literature and patented in 1957[1]. Carbopol polymers are synthetic high molecular weight, cross linked, acrylic acid based polymer. These are polymers of acrylic cross-linked with polyalkenyl ethers or divinyl glycol. Carbopol polymers family are chemically similar in that they are all high molecular weight, cross linked polyacrylic acid polymer[2]. However the polymer differs by crosslink density and can be grouped into two categories.

Carbopol Homopolymers: Acrylic acid cross linked with allyl sucrose (or) allylPentaerythritol.

Carbopol Copolymer: Acrylic acid and C-10, C-30 alkyl acrylate cross linked with allylPentaerythritol.

Numerous enhancements have been made to the carbopol polymer family over time to address formulation demands, increase product robustness and improve product handling during processing. Carbopol polymers are widely accepted ingredients in development of pharmaceutical dosage forms such as controlled release tablets, oral suspension, Novel Delivery Systems, as well as a variety of topical products [3]. Based on the usage of carbopol polymers make a potential candidate for the development of oral solid dosage form (OSDF). The present review work divulged about the properties, manufacture, pharmaceutical applications of carbopol 71G-NF polymer [4].

2. Structure of Carbopol

Carbopol polymers are offered as fluffy, white, dry powders (100% effective). The carboxyl groups provided by the acrylic acid backbone of the polymer are responsible for many of the product benefits. Carbopol polymers have an average weight of 76 per carboxyl group [5].

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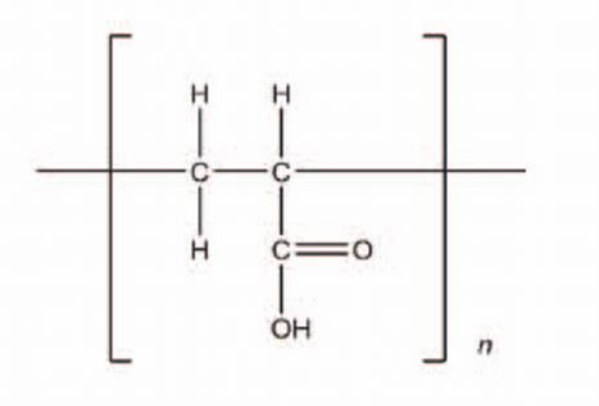

Figure 1 (a) General structure of Carbopol polymer

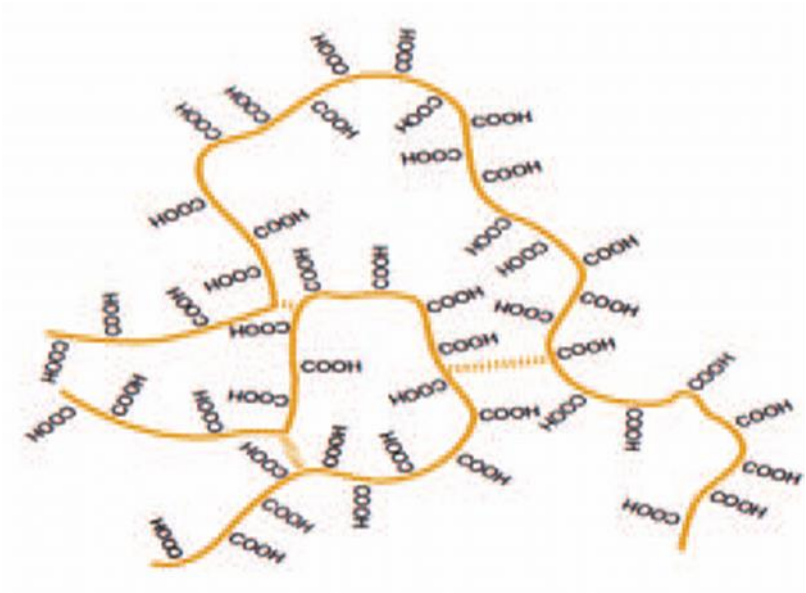

Figure 1 (b) Systematic diagram of a molecular segment of a cross linked polyacrylic acid polymer

3. Physiochemical properties

Table 1 Physiochemical properties of Carbopol polymers [6]

Appearance	Fluffy, white, mildly acidic polymer.
Bulk Density	Approximately 208kg/m^3
Specific gravity	1.41
Moisture content	2.0 % maximum
Equilibrium moisture content	8-10% (at 50% relative humidity)
Pka	6.0±0.5
PH	4.0 -6.0
Equivalent weight	76±4
Glass transition temperature	100-105C (212-221F)

4. Method of manufacture

Carbopol polymers are manufactured by cross-linking process. Depending upon the degree of cross-linking and manufacturing condition different grades of are available [7]. Each grade is having its significance for its usefulness in pharmaceutical dosage forms. Carbopol 71G, 971P, 974P are cross linked with allylPentaerythritol and polymerized in

ethyl acetate [8]. All the polymers are fabricated in ethyl acetate are neutralized by 1-35 potassium hydroxides [9]. Though Carbopol71 G-NF polymer is manufactured by the roller compaction of Carbopol 971P NF polymer [10].

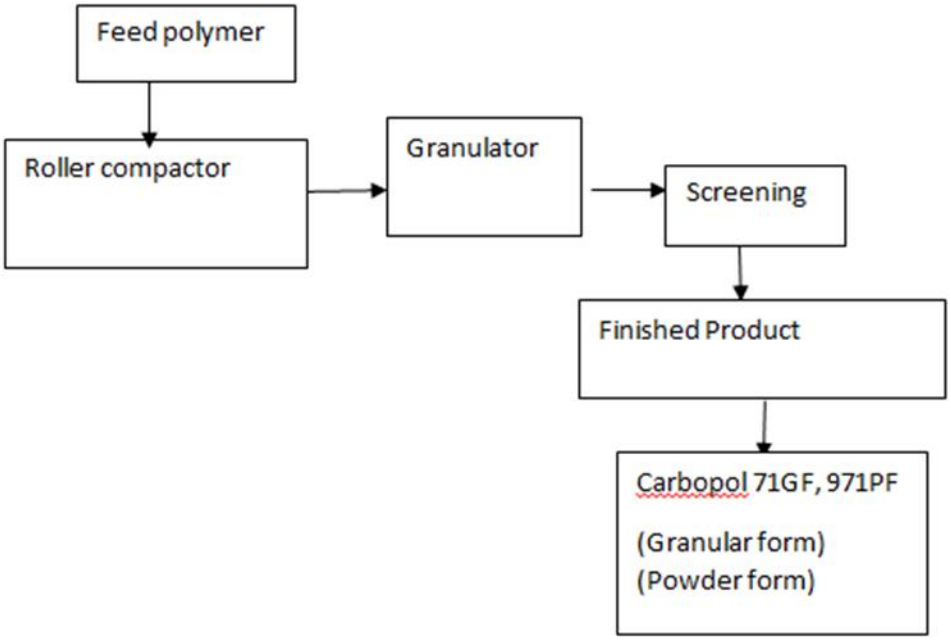

Figure 2 Schematic representation of the manufacture of Carbopol 71G –NF polymer

(Courtesy: Lubrizol advance material, Inc. Ohio)

Figure 2 (a) Granular Form

Figure 2 (b) Powder Form

5. Typical properties

5.1. Swelling Property

Carbopol polymers are bearing very good water sorption property [11]. They swell in water up to 1000 times their original volume and 10 times their original diameter to form a gel when exposed to a pH environment above 4.0 to 6.0[12]. This leads to swelling of the polymer. Thus swelling tendency of the carbopol polymers are largely dependent upon the cross linking density and viscosity nature. The Carbopol polymers have exhibited with respective different grade [13].Each grade has different swelling property which resulted in selection of suitable candidate for the development of controlled release OSDF [14].

5.2. Rheological property

The different grades of carbopol polymers have different rheological properties, a reflection of particle size, molecular weight between cross links and the fraction of the total units [15-19]. Which occur as a terminal free chain end. Viscosity range of different carbopol polymers are shown in the table 2.

Table 2 Viscosity Range of Different Carbopol Polymers.

POLYMER	VISCOSITY
Carbopol 934 NF	30500-39400
Carbopol 934P NF	29400-39400
Carbopol 71G NF	4000-11000

5.3. Mechanism of drug release

A molecule of these polymers in the dry powder state is tightly coiled, thus limiting its thickening capability [20-21]. When dispersed in water the molecule begins to hydrate and uncoil slightly, generating an increase in viscosity [22]. There are two mechanism by which the molecule can become completely uncoiled, providing maximum thickening, emulsion formation and stabilization or bio adhesion performance [23].The most commonly used mechanism is accomplished by neutralizing the polymer with a suitable base [24-26]. Neutralization ionizes the carbopol polymer backbone. A second thickening mechanism involves the use of a hydroxyl donor [27]. The combination of a carboxyl group and one or more hydroxyl donors will result in thickening because of the formation of hydrogen bonds [28].

Hydrated polymer Dry polymer

Figure 3 Carbopol polymers 71G and 971P hydration mechanism

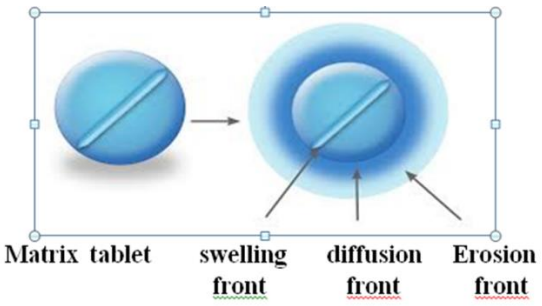

Figure 4 Drug release mechanism of OSDF

5.4. Incompatibility

Carbopol 71G-NF is discolored by resorcinol and is incompatible with phenol, cationic polymers, strong acids, and high levels of electrolytes. Certain antimicrobial adjuvant should also be avoided or used at low levels. Carbopol 71G-NF polymer also forms pH- dependent complexes with certain polymeric excipients [30]. Adjustment of pH and solubility parameter suggested overcoming the incompatibility [31].

6. Advantages of carbopol71G-NF polymer in OSDF

- It has good flow in high speed equipment
- It has good compressibility and reproducibility (intra and inter- lot).
- It is used as direct compressible excipients in the controlled release tablets.
- It can be combined with powder grade Carbopol polymers or other controlled release excipients to improve the flow ability of the formulation and achieve flexibility in drug release performance.
- Global Pharmacopoeial status and U.S and European Drug Master File (DMF).

7. Application of carbopol71 G-NF polymer

7.1. Development of Controlled Release OSDF

Carbopol 71G-NF is being used in the controlled release solid dosage formulations. The numbers of manufactures commercializing controlled release tablets using carbopol 71G-NF are increasing considerably in recent period of development [32]. Tablet formulation using carbopol 71G-NF have demonstrated Zero- order and near Zero-order release kinetics [33]. These polymers are effective at low concentration (less than 10%). Carbopol polymers have great extent in formulating dosage forms [34-37]. Because of these factors carbopol polymers are swelling rapidly in water and absorb great quantities, to avoid the use of flammable solvents, roller compaction is being used as the method to prepare a new form of Carbopol 71G-NF, 971G-NF polymer [38]. It is useful and versatile controlled release additive for tablet formulations inn direct compression. They act as an efficient binder in dry as well as wet granulation process [39].

7.2. Bioadhesive property

Many hydrophilic polymers adhere to mucosal surface as they attract water from the mucus gel layer adherent to the epithelial surface [40-42]. Carbopol polymers have been demonstrated to create a tenacious bond with the mucus membrane resulting a strong bioadhesion [43]. Many commercial oral and topical products available today and under investigation have been formulated with carbopol polymers, as they provide numerous benefits in bioadhesive formulations [44].

7.3. Cross-linking property

Carbopol 71G-NF is lightly cross linked polymer typically most efficient grade of controlling the drug release [45]. This polymer have fewer crosslink sites to constrain the polymer and a homogeneous gel structure forms a lower concentration compared to highly cross linked polymer .As a result , the active is less subject to diffusion through the gel layer[46].

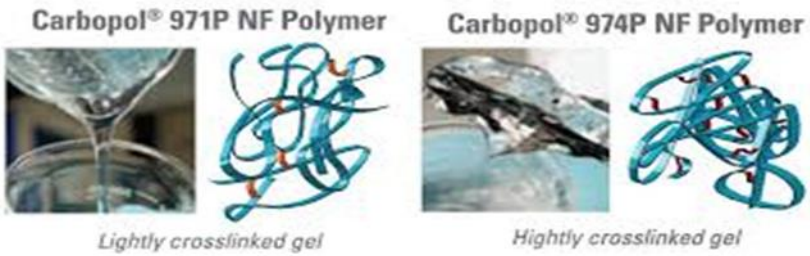

Figure 5 Cross linking diagram of Carbopol polymer

(Courtesy: Lubrizol advanced material, Inc. Ohio)

8. Regulatory status of carbopol polymers

Regarding compendia classification, the European Pharmacopeia has only one monograph which applies to Carbopol polymers titled "Carbomers" [47]. The United States Pharmacopeia / National Formulary have several monographs for different Carbomers grades [48]. The monographs titled "Carbomers XXX" are assigned to products manufactured with the use of benzene and they separate the carbomer products are based on polymer structure [49].

9. Conclusion

Recently carbopol polymers have widely used in the development of Oral Solid Dosage Forms (OSDF) due to their unique properties. Based on the review it was ended that the use of Carbopol 71G-NF polymer in the formulation of OSDF because of their swelling, bio adhesive and cross-linking property. Day by day number of research work engaged in Carbopol polymer is increasing and become a very good upper crust in the development of oral solid dosage form (OSDF).

Compliance with ethical standards

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Disclosure of conflict of interest

None.

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