Multifaceted Polymer Gellan Gum In Pharmaceutical Field

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Abstract—The microbial polysaccharide gellan gum is an anionic linear polymer. Since its early discovery, it has been widely employed in the food and cosmetics sectors because of its unique gelling feature and theological behavior of its aqueous solution. Recent research has shown a wide range of possible applications for gellan gum, a naturally occurring polymer, and its hydrogel in tissue engineering and medication delivery. In addition to producing a transparent, stable hydrogel, gellan gum is safe, biocompatible, and biodegradable. In certain instances, the mechanical characteristics of gellan gum hydrogel resemble those of typical human tissues. These features make gellan gum a viable source of biomaterials with various properties. Nevertheless, there are inherent drawbacks to gellan gum-based hydrogels as materials for tissue engineering, including their lack of durability.

The creation of modified gellan gum has great promise for the future of biomedical materials. In this study, we give a summary of the gellan gum's gelation process, discuss several modification techniques, and emphasize the uses of gellan gum and hydrogels derived from modified gellan gum in the biomedical industry. Additionally, we highlight many important problems that gellan gum-based polymers for tissue engineering still need to resolve.

key words-Gellan gum; Hydrogel; Gelation mechanism; Chemical modification; Composite modification; Biomedical materials.

Introduction

A common green biopolymer used for thickening, stabilizing, and suspending purposes in the food, cosmetic, and pharmaceutical sectors is gellan gum. With its ability to effectively encapsulate medications or living things in the spaces between polymer chains, multivalent cation hydrogels may be created. These hydrogels can absorb large amounts of water and biological fluids. A growing number of areas' researchers are focusing more on gellan gum hydrogels because of their potential for medication and cell delivery. It is presently not possible to obtain reports that provide an overview of these developments. To close that gap, this essay aims to. In this work, we want to discuss the most recent research on gellan gum hydrogels for drug administration, cell distribution, and tissue repair.[1]

Microbial exopolysaccharides have a wide range of uses in the food, pharmaceutical, and other sectors due to their unique structure and physical properties. These applications include those of emulsifiers, stabilizers, binders, gelling agents, coagulants, lubricants, film formers, thickening, and suspending agents. [2]. These biopolymers are gradually taking the lead over naturally occurring gums derived from various plants and marine algae, and they are rapidly becoming important in the industrial sector.

Biopolymers that are either commercially available or have been the subject of in-depth research include xanthan from Xanthomonas campestris, gellan, and several structurally related polysaccharides from the strain Sphingomonas paucimobilis, bacterial alginates secreted by Pseudomonas sp., Azotobacter vinelandii, and Azotobacter chrococcum[3].

Hydrocolloids are a broad and varied family of polymeric materials that are mostly made up of polysaccharides and a small quantity of proteins. Hydrocolloids are a diverse family of long-chain polymers that are partly soluble, easily dissolved in water, and prone to swelling. [4]. Hydrocolloids alter a solution's physical properties by gel formation, thickening, emulsifying, coating, and stabilizing. Polysaccharides, or carbohydrates, are the categories for hydrocolloids, which include starch, agar, various gums, etc. Hydrocolloids come from a variety of sources. They are created by bacteria that come from algae, plants, and even certain animals in the wild. They could also resemble derivatives of cellulose and be semi-synthetic. Hydrocolloids spread particles and create gel by reacting with water. For this reason, they are often referred to as hydrophilic colloids[5].

Hydrocolloids are extensively employed as food additives since gelatin protein is recognized as an extraordinary member of this polysaccharide club because of its remarkable hydrophilicity and multi dispersion capabilities [6]. Hydrophilic polymers, also known as colloidal particles, are dispersed in water to form a hydrocolloid, a particular kind of colloidal system. (Saha and Bhattacharya, 2010). The hydrocolloid can have a range of forms, including gel, aqueous, and solid, depending on the quantity of water present. Reversible or irreversible hydrocolloids (single state) are both possible. For instance, agar is a reversible hydrocolloid made of seaweed extract that can exist in both gel and solid phases. It can oscillate back and forth between the two states simply by changing the temperature. Natural sources are the source of many hydrocolloids. Citrus peels are the source of pectin, whereas cow protein is hydrolyzed to create gelatin and agar/carrageenan is taken from shellfish. The food sector uses hydrocolloids primarily to modify the viscosity of goods like sauces. Advanced skin wound dressings are one of the additional uses for hydrocolloids. (Saha and Bgattacharya, 2010; Bixler and Porse, 2011). Hydrocolloids are substances that are generally utilized to change tissue, regulate crystallization, stop dehydration or synergy, coat flavorful and aromatic components, improve physical stability, and produce films. (Jabraili et al., 2021), produce gel structure and increase the consistency of liquid, semi-liquid and Semi-solid materials.

Many of them are not metabolized in the human body and have low energy and can be used as useful compounds in diet foods. Large molecules of hydrocolloids are able to significantly affect and control the rheological and textural properties of their content systems at relatively low and low concentrations, by proper interaction with a large number of water molecules. These compounds increase the viscosity by absorbing water and thus increase the stability of some food systems [7].

2. History

Gellan gum is the generic name for extracellular polysaccharide produced by bacterium Pseudomonas elodea. Kaneko and Kang[8] discovered the polymer in the laboratory of the Kelco Division of Merck and Co., California, USA in 1978. It had previously been referred to by the code names S-60 or PS-60. The gellan gum-producing microorganism was isolated from the Elodea plant tissue. Further studies revealed that the bacterium was a new strain of the species Pseudomonas, and hence termed as Pseudomonas elodea [9]. In 1994, it was discovered that gellan-producing bacterium was Sphingomonas paucimobilis and classified in the a-4 subclass of the Proteobacteria. Successful toxicity trials were completed and gellan gum received approval for use in food in Japan in 1988[7].

The US FDA approved gellan gum for use as a food additive in 1992. Specifications for gellan gum were prepared at the 46th Joint Expert Committee on Food Additives (JECFA) in 1996 and published in FNP 52 Add 4 in 1996[6].

3. Biological source

Gellan Gum is a hydrocolloid produced through fermentation processes. It is a carbohydrate polymer produced by the bacterium Sphingomonas elodea formerly known as Pseudomonas elodea. Following fermentation, the media is heated to kill viable cells[10]. The isolation and purification of the Gellan Gum includes precipitation with alcohol. The level of acyl groups can be reduced with an alkali treatment prior to alcohol precipitation to produce Low Acyl (LA) forms compared to the native High Acyl (HA) form of Gellan Gum[10].

Description

Gellan Gum is a kind of extra cellular polysaccharide excreted by microorganism Pseudomonas elodea. It is a linear structure with a repeating unit of tetrasaccharide. As emulsifier, suspension agent, thickener, stabilizer, gelling agent, tissue culture medium, film former and lubricant, gellan gum has been widely used in over 20 fileds, such as food, cosmetics, detergent, ceramics, petroleum exploration and coating for chemical industry, it is considered as one of the most advanced food additives in the world[11].

Types of Gellan Gum gel

1. Firm, brittle gel - Using low acyl gellan gum in very low concentrations - from just 0.1% -firm and brittle gels can be made. These gels are crystal clear, making them very appealing visually[12].

2. Fluid gel - By agitating low acyl gellan gum gels as they cool, fluid gels can be created. They have apparent low viscosity, yet have remarkable suspending properties, successfully suspending particles such as coloured spheres, herbs, and even gases[12].

3. Elastic gel - By incorporating high acyl gellan, a far more flexible result can be achieved. The resultant gel can be made into thin sheets that can be rolled or folded[12].

4. Spheres and strands - a pure, gellan gum solution can be dropped into an ion rich water solution to form gelled spheres or strands[12].

Gel Formation

1)Dispersion

- Poor dispersion will result in incomplete hydration and loss of gum functionality.

Solutions:

- Blending with dispersants such as sugar, sodium citrate etc.

- Stirring or starting the agitator before adding.

- Using well dispersion products such as KELCOGEL or NRGEL[13].

2) Hydration:-

-Concentration of ions in solution will effect the hydration temperature such as calcium, sodium.

-Low acyl gellan gum requires a temperature of 75 °C(167°F) to fully hydrate the gum.

-High acyl gellan gum hydrates between 70°C and 80 °C(158°F and 176°F) even in relatively high ion concentrations[13]

3)Gel formation:-

In the absence of added cations, low acyl gellan gum gels set at around 25°C (77°F), where high acyl sets at around 65 °C (149°F). With added calcium or sodium ions, the setting temperature increases[13].

4) Gel Texture:-

Low acyl-hard brittle gel

High Acyl-soft elastic gel

Blending two types with vary ratios a wide variety of textures can be obtained.

It is possible to obtain textures close to those of carrageenan and gelatin gels[13]

4. Physico-Chemical Properties

Gelling characteristics and texture properties of gellan gum Gelation of gellan solutions occurs abruptly upon heating and cooling of gellan gum solutions in the presence of cations. Such sol-gel transitions are considered as phase transition. The gelation of gellan gum is a function of polymer concentration, temperature, and presence of monovalent and divalent cations in solution. [14] At low temperature gellan forms an ordered helix of double strands, while at high temperature a single stranded polysaccharide occurs, which significantly reduces the viscosity of the solution. The transition temperature is approximately 35 °C, but can range from 30–50 °C. Below transition temperature, a stiff structure is obtained (setting point), and results in gel formation.

The mechanism of gelation involves the formation of double helical junction zones followed by aggregation of the double helical segments to form a three-dimensional network by complexation with cations and hydrogen bonding with water [15]. Addition of monovalent or divalent cations during cooling markedly increases the number of salt bridges at junction zone, thereby improving the gelling potential of gellan gum. tors on the gel strength.

Acetyl content

is the most important factor affecting the gel strength. Gellan gum with different acetyl con-tent gives gels with different properties[16]. Native gellangum provides soft, elastic, thermoreversible gels, and isvery weak because of bulky acetyl and glyceryl groupsthat prevent close association between gellan polymerchains in bulk-helix formation, and hinder compact packing of the cross-linked double helix. Deacetylated gellan gum forms firm, brittle and thermoreversible gelbecause of the absence of acetyl and glyceryl groups[17]

A comparison of some of the main physical properties of High Acyl and Low Acyl Gellan Gum:-

	High Acyl Gellan Gum (KELCOGEL® LT100	**Low Acyl Gellan Gum**
Molecular weight	1 – 2 x10^6 Daltons	2 – 3 x10^5 Daltons
Solubility	Hot water	Cold or hot water
Set Temperature (ºC)	70 – 80	30 – 50
Thermoreversibility	Thermo reversible	Heat stable

Table 1.

1. **Prepare DIY media for gellan gum production**

Culturing *S. paucimobilis* for gellan gum production is a two-step process in which a starter culture is propagated in a rich medium and then transferred to a minimal medium. The initial culture phase in rich medium allows cells to rapidly achieve high densities before they are used to inoculate the gellan production medium, where little further growth occurs[18] . Gellan gum production is induced under nitrogen starvation in the presence of excess carbon, which serves as the substrate for EPS(Extracellular polymeric substance) synthesis. Therefore, the gellan production minimal medium contains a high C:N ratio to favor maximal EPS accumulation.[19] When carrying out this procedure, you should wear appropriate personal protective equipment, such as safety goggles, gloves, and a lab coat, and use heat-resistant glassware (e.g., Pyrex). For the two-step culturing method, you will need to first make a DIY rich medium, General Kitchen Broth (GKB)[20], which substitutes for a conventional *S. paucimobilis* rich medium (e.g., YPG) used in the first step. To make GKB, mix the following ingredients in 100 mL of water: 0.5 g dried skim milk, 0.25 g marmite, and 0.1 g honey. For the second step, we developed a minimal medium recipe (DIY-GPM) by identifying DIY equivalents for components of standard gellan production medium [21]. To make DIY-GPM, mix the following in 1 L of water: 0.03 g dried skim milk, 0.5 g marmite, 24.35 g honey, 1 g table salt, 1.2 g Epsom salt, 10 g trisodium phosphate, 3.75 mL clear ammonia (e.g., Austin's brand, ~2.5% w/v ammonium hydroxide), and 3.1 g citric acid. Ensure that the GKB and DIY-GPM components are well mixed and sterilize them, using an autoclave or pressure cooker.[20]

Culture *S. paucimobilis* for gellan gum production

Once the media have cooled to room temperature, start a 100 mL culture of *Sphingomonas paucimobilis* ATCC 31461 in GKB. Allow this to grow to saturation by incubating for two days, with shaking and at 30°C if possible . Next, add this entire culture to 1 L of sterile DIY-GPM and incubate under the same conditions until the culture becomes gelatinous and homogenous. We found that incubating for eight days at 30°C with shaking produced a sufficient yield of gellan gum.[20] You should inspect these cultures every day. A culture that is ready for pouring plates should be highly viscous and adhere to the side of the flask when it is tilted.[20]

Pour gellan gum plates

Next, add 0.4 g/L of Epsom salt to the *S. paucimobilis* culture. This provides magnesium to strengthen the gellan polymer matrix. Also, add any other nutrients needed by your microbe of interest. For example, we found that adding 10 g/L of marmite improved growth of *E. coli* and *S. cerevisiae*. Heat the entire culture in a microwave using a medium setting until it becomes fluid and homogenous, watching carefully to avoid overboiling. At this point, the mixture is sterile and can be poured into petri dishes to make ~40 standard plates. We observed normal colony growth rates and morphology on these DIY gellan gum plates. which describe appropriate personal protective equipment and sterile procedures for working safely with BSL1 microbes.[21]

2. (1) APPLICATION OF PHARMACEUTICAL

Oral drug delivery

- The active compound is only a part of the formulation which must be delivered to the desired region of the body[22]. Because of the convenience and easiness of administration, oral route is currently the most extensively studied one (Rathbone et al., 2003). It was shown that drug release from natural hydrophilic polymer matrices is a result of complex interaction between swelling, diffusion and erosion.[23]
- In the aqueous environment polymeric gums hydrate from the periphery toward the centre and form a swollen, mucilaginous mass which further prevents penetration of the fluid into the tablet. As a result, the diffusion of the drug molecules into the surrounding medium is hampered.[24]

Solid dosage forms

- Gellan gum has been used in oral drug delivery mainly as a disintegrating agent in immediate release tablets or a matrix-forming excipient for sustained release .[25]
- Both applications are based on swelling behavior but the concentration of gellan is crucial for the effect.
- The fast drug release tablets require low content of the polymer (Emeje et al., 2010), while the prolonged release tablets usually contain higher amounts of gellan .[26]
- The rate and extent of swelling is significantly higher in simulated intestinal fluid (SIF) than in simulated gastric fluid (SGF). However, water uptake is not based on a diffusion mechanism, as it proceeds with a constant velocity independently of the medium pH [27].

Gel electrophoresis in biological research

- Gels of gellan can be used as a solid matrix for separating DNA fragments on the basis of size by electrophoresis. Gel electrophoresis is a widely practiced and key procedure in molecular biology. Gellan-based electrophoresis gels must include a second polymer such as hydroxymethylcellulose or polyethylene oxide to reduce electroosmosis.
- In this application gellan can replace highly refined agarose, which is very costly and used at about 1 %. By contrast, gelllan costs much less agarose and is required only at 0.125 %.[28]

In situ gelling Ophthalmic preparation in ion activation

- These are solution of low viscosity that are instilled in eye drop and change into a gel like system when they come in contact with the corneal fluid.
- Gelrite is a polysaccharide , a low acetyl gellan gum show phase transition in presence of mono or di valent cation.[29]
- Gelrite solution, a novel ophthalmic vehicle, gels in the presence of mono or divalent cations. In the conjunctival sac 'ion-activation' of the sol/gel transition is accomplished by the lacrimal fluid. A 0.6% Gelrite vehicle has been compared to an equiviscous solution of hydroxyethylcellulose (HEC) using timolol maleate as a drug probe. In vitro release rates of timolol from HEC and Gelrite gel were similar.[30]
- In vivo, the formation of the gel prolonged precorneal residence time and increased ocular bioavailability of timolol in the cornea, aqueous humor and iris + ciliary body of albino rabbits.[31]

Gellan Gum for Capsules in Pharmaceutical Industry

- Gellan gum can be used to produce easy-to-swallow solid dosage forms, such as gels and coated tablets, and to modify the rate of release of active ingredients from tablets and capsules.
- Gellan gum is also conveniently used for controlled or sustained release of various drugs and also for micro-encapsulation preparation. The bioavailability from the gellan gels increases 4-5 folds in rats and 3 folds in rabbits compared to a commercial sustained release liquid dosage form.[32]

- The ability of gellan to form gels in the presence of calcium ions enabled us to prepare capsules by gelation of this polysaccharide around a core containing starch, calcium chloride and a model drug.
- Release from the dried capsules was studied in vitro by means of the rotating basket technique (USP) in different environmental conditions (distilled water, pH = 2.0, pH = 6.8) and the effects of the presence of increasing amounts of drug in the formulation were also investigated.
- The behaviour of the gellan capsules was compared with that of beads prepared with the same polysaccharide but containing different additives.
- Results obtained indicate that gellan is suitable for the formulation of sustained release capsules and that solvent uptake by the dried capsules is most likely the main factor capable of affecting the rate of delivery from the tested preparations.[33]

Hydrogels based on gellan gum in cell delivery and drug delivery

- Gellan gum is a green biopolymer widely used in pharmaceuticals, cosmetics and food industries as suspending, stabilizing, and thickening agent.[34]
- It is able to form hydrogels with multivalent cations which absorb high volume of water or body fluids and adequately encapsulate drugs or cells in interstitial spaces among polymer chains.[35]
- The investigation on cell delivery and drug delivery using gellan gum hydrogels has been expanded in many fields.
- Recent working on gellan gum hydrogels for the delivery of drug and cell delivery to rejuvenate the tissue.[36]

(2) Biomedical applications of gellan gum

Tissue engineering

- Gellan gum has been recently investigated in the field of tissue engineering, mostly as a material for cartilage reconstruction.
- It is important to note that the ability of cartilage to self-repair after degeneration or mechanical damage is limited.[37]
- Therefore, novel biomaterials with the potential to replace the damaged tissue or to induce regeneration are of great importance.
- Gellan is also considered as a material suitable for the treatment of intervertebral disc disorders related to the disfunction and deformation of nucleus pulposus, the central part of the interverte bral disc.
- This painful disorder strongly impairs patients' quality of life. Moreover, standard therapies with anelgesic drugs or surgical treatment are often ineffective.[35]

Surgery and wound healing

- Recent studies revealed that due to biocompatibility and non- 492 toxic properties, gellan gum can be used as a component of novel wound dressings designed to inhibit postsurgical adhesion and 494 prevent scar formation.[38]
- No toxicity toward blood and fibroblast cells was observed. The films possessed antiplatelet (antiadhesive) properties .[39]

Other Biomedical Application

- The number of reports concerning the application of gellan gum in the different areas of medicine is still emerging.[40]
- Some of them are particularly worth noting. Gellan has been considered as a material for preparation of dental cavitiy fillings after tooth extraction.[41]Various concentrations of gellan in the range of 0.75–1.75% were tested.[42]

(3) Application in non-pharmaceutical field :-
Transparent suspending beverages

low acyl gellan gum can be used to formulate clear or transparent solution.it helps to keep cubes or insoluble particles suspended in beverages, because of its excellent fluid gel properties good suspension at low viscosity can be achieved.[43]

Features of Gellan Gum:
-Excellent Acid / Heat Stability
-Low Acyl Gellan Gum solution is Clear and Transparent
-Suspending quick and stable
-Outstanding Flavor Release
-Low Dosage (recommended dosage is 0.012%-0.03%. Blending with other hydrocolloids is advised to increase the performance.[43]

Plant tissue culture

Low acyl gellan gum is ideal for using in Plant Tissue Culture Medium application and Micro-Organism Tissue Culture. It is widely used in tissue culture labs and is a desired alternative to to Agar .The Gel Strength and the transmittance of this product could be adjusted subject to customer's actual application.[43]

Advantages
-The gellan gum we offered with high transparency rate over 85%
-It is an alternative to agar, used at only 1/5 the agar use level
-Resist contamination by molds, it is easily washed from the plant tissue for transplanting
-Allows clear observation of root and tissue development.[43]

Air freshener

Low Acyl Gellan gum is widely used in air fresheners because of its high gel performance, high transparency,good water holding capacity and flavor release. Meanwhile, Gellan gum enables air freshener gel of crystal clarity to be formulated, the irreversible gel performance and high melting temperature of gel make it suitable for used in high temperature environment such as carsReference recipes:Gellan gum LA 0.5%, calcium lactate 0.05%, emulsifier, parfum, colourings.[43]

Bakery filling or preparation

Low acyl gellan gum can be used in fruit preparation like heat-stable bake stable fruit filling or other preparation like yoghurt fruit preparation, with excellent thermal and freeze-thaw stability, good moisture retention, low use levels, good flavor release and no impact on color.
The most important advantage is that the gels formed withstand higher temperature and not melt, so it is a perfect gelling agent for bakery application.[43]

Confectionery-

Gellan gum is widely used in the food industry for gelling, thickening and stabilizing. It has particular application in formulations with high sugar or starch content. Gellan gum systems show excellent stability (heat, acid and base) and also give fluid gels when sheared during cooling and are therefore ideal for use in suspension and pumping or filling applications.[43]
(a) ability to achieve a diverse range of textures;
(b) reduced setting time to allow for faster removal from moulds;
(c) high gel strength;
(d) sparkling clarity.[43]

Jelly Dessert
LA (low acyl) gellan gum is traditionally used in fruit jellies. HA (high acyl) and LA blends can be used to achieve a range of textures in powdered applications. LA gellan gum can be used to replace gelatin in some vegetarian products, desserts and savory applications, such as aspic-type products.[43]

Shear Gels

Gellan gum gels that are subjected to some level of shear or agitation on cooling, form fluid gels that have a weak gel structure and that are ideal for use as suspension agents. Fluid gels can be produced in a number of ways including standard filling procedures and even in 'shake before use applicationBoth HA and LA gellan gums are used in such applications. HA gellan fluid gels are less sensitive to the ionic conditions (in the formulation) and have more elastic flow properties than LA gellan fluid gels. [43]

Fluid gels
fruit and dairy based beverages; some dairy products;spreads including low fat/no fat applications and dressings and sauces. Soya milk is a classic example of gellan suspension, it works at about 300 ppm with LA gellan.[43] Gellan gum is widely used in the food industry for gelling, thickening and stabilizing. It particular application in formulations with high sugar or starch content. Gellan gum systems show excellent stability (heat, acid and base) and also give fluid gels when sheared during cooling and are therefore ideal for use in suspension and pumping or filling applications. Dairy Products: gellan gums have the ability to form gels in the presence of milk proteins and thus are used widely as stabilizing and texture agents in dairy products. Typical products are beverages, puddings and desserts, cream, ice cream, set and stirred yogurts. Both HA and LA gellan gums hydrate well in milk based systems and rarely require the addition of extra ions or sequestrants to gel.
Good heat stability and low viscosity at high temperature benefits application in UHT or HTST treatments.[43]

B) High Acyl Gellan Gum Solution and Application

1) Natural Vegetable and Fruits Juices

High Acyl Gellan gum is in natural organization without deacylation. The organization of High Acyl Gellan Gum is a premium quality refined tan / white powder. It is widely used in applications like in fresh vegetable or fruits concentrates beverage.[43] Natural Vegetable or Fruit Juices with high sugar content, so low acyl gellan gum is not suitable for this application. it is sensitive to acid / low pH solutions. When used in low pH beverages, the acid would damage the organization of gellan gum thus you can not get the performance you need, for example, fruit pulps might settle down or water might be acid out.[43] The key topic of use gellan gum in low pH condition is to make it acid-stable.

2) Vegetable Protein Drinks

The vegetable protein beverage is the fastest growing soft drink industry, plant protein in recent years. The main raw materials are nuts and fruit pulps. [43]High acyl gellan gum used in vegetable protein drinks can improve the taste, and also has a function of increasing the consistence and stability of the protein. Moreover, it can also be used with other hydrophilic colloids, such as carrageenan, guar gum, locust bean gum, etc.[43]The combination of synergistic effect are good and stable. High acyl gellan gum is usually used in walnut milk, peanut milk, cocoa milk, corn juice, mung bean juice, etc.[43]

3)Gellan gum solution

Beverage containing gellan gum which does not require stabilizers. The amount of gellan gum present in the beverage is between about 0.01% and 0.15% gellan gum. The beverage can be prepared by hot-filling or shear cooling.[43] Shear cooling is used in the production of custards, gravies, and chocolate milk, in which fluid mass is formed during homogenization, pasteurization and cooling. Chocolate milk, for example, is processed with carrageenan under high temperature, short time pasteurization, and then shear cooled. During cooling, a gel matrix forms. [43] At the end of the shearing and cooling operations, the resulting product is a cooled, non-gelled product properties.[43]

Conclusion

Gellan gum is one of the most extensively studied natural-origin polysaccharides, utilized as a multifunctional excipient in various dosage forms. Its advantageous properties such as biodegradability, non-toxicity, rapid gelation in the presence of cations, high water-holding capacity, and mucoadhesive potential make it an invaluable component in oral, ophthalmic, nasal, and other formulations. Additionally, gellan gum has shown promising applications in biomedical fields, serving as an absorbent material in wound healing, a tool in stomatology, and a cell carrier in tissue engineering.

Despite its broad range of potential uses, most gellan gum-based formulations remain at the laboratory investigation stage. While several reviews (Giavasis et al., 2000; Bajaj et al., 2006; Morris et al., 2012; Prajapati et al., 2013) have explored the versatile applications of gellan gum, none have specifically focused on its role in pharmacy and medicine.[44]

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