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Review Article

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SOURCES OF CELLULOSE AND THEIR APPLICATIONS – A REVIEW

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ABSTRACT

cellulose is a polysaccharide polymers.The amalgamation of polymer and pharmaceutical sciences led to the introduction of polymer in the design and development of drug delivery systems. Polymeric delivery systems are mainly intended to achieve controlled or sustained drug delivery. The major industrial source of cellulose is vascular plants. Resources for most applications in the building industry, and the cotton plant are the major source for textiles. Most paper products originate from wood pulp, while textile fibers are generally not isolated from woody fibers. Cotton fibers are a biological source of almost pure cellulose, but this is not usually used in food grade cellulose and are used instead for various cellulose derivatives, pharmaceutical, or chemical engineering uses, such as chromatography, paints, and explosives. Some other sources for cellulose are jute, hemp, corn, flasks, rice, wheat straw, sisal. Bacterial sources of cellulose have also been developed using *Acetobacter xylinum* that ferment substrates of glucose from corn syrup Different sources of cellulose are used for different purposes, for economic reasons. Pulp and paper are usually produced from wood Different extraction procedures for cellulose have been developed, By using different processes oxidation, micronization, etherification and esterification convert the prepared celluloses in to cellulose derivatives. The obtained derivatives are hydroxylpropylmethylcellulose(HPMC), hydroxypropylcellulose(HPC),microcrystallinecellulose(MCC),silicicedmicrocrystallinecellulose(SMCC),hydroxyethylcellulose(HEC),sodiumcarboxymethylcellulose(SCMC),ethylcellulose(EC)methylcellulose(MC),oxycellulose(OC),hydroxylethylcellulose(HEC)etc used in pharmaceutical application. Cellulose depending up on its concentration it will act as diluents, disintegrant, binder. As cellulose is having tremendous value it is widely used in pharmaceutical applications.

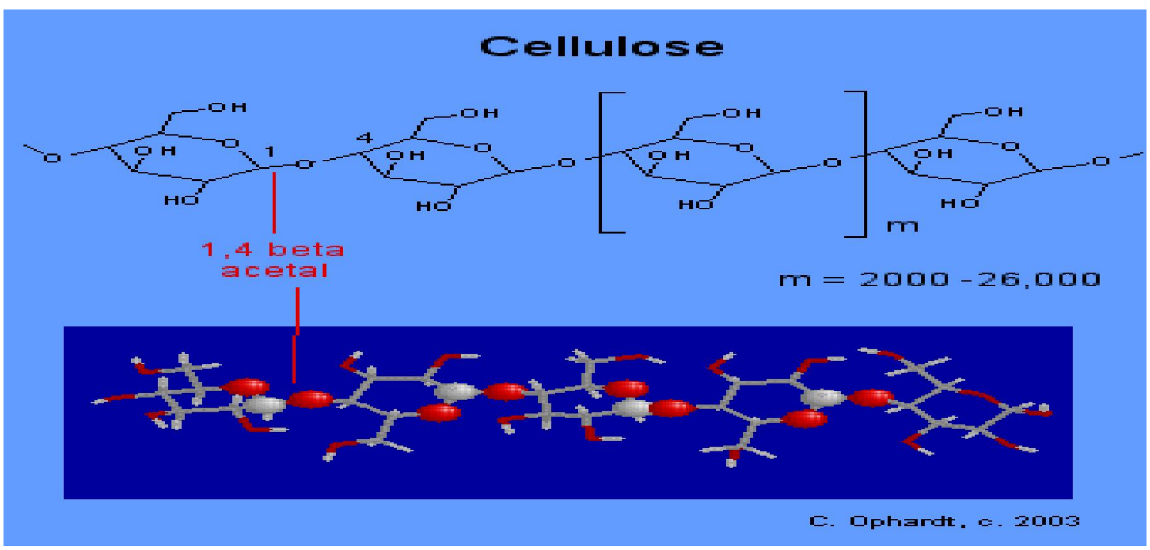
Keywords: cellulose, extraction procedure for cellulose, cellulose derivatives and applications

INTRODUCTION

In 1838 by the French chemist Anselme Payen, While studying different types of wood, Payen obtained a substance that he knew was not starch (glucose or sugar in its stored form), but which still could be broken down into its basic units of glucose just as starch can. He named this new substance "cellulose" because he had obtained it from the cell walls of plants. Payen isolated it from plant matter and determined its chemical formula[1-3].In 1870 by Hyatt Manufacturing Company they used cellulose to produce first successful thermoplastic polymer.In 1920 by the Hermann Staudinger determined the polymer structure of cellulose .In 1992 by Kobayashi and Shoda the compound was first chemically synthesized (without the use of any biologically derived enzymes).[4]

Cellulose is a Polysaccharides

These carbohydrate polymers consisting of tens to hundreds to several thousand monosaccharide units. (Glucose). Cellulose is the main building material out of which plants are made, and plants are the primary or first link in what is known as the food chain (which describes the feeding relationships of all living things), cellulose is a very important substance. Most abundant naturally occurring biopolymer [5,6]. Various natural fibers such as cotton and higher plants have cellulose as their main constituent [7,8]. It consists of long chains of anhydro-D-glucopyranose units (AGU) with each cellulose molecule having three hydroxyl groups per AGU, with the exception of the terminal ends.



Even though we cannot digest cellulose, we find many uses for it including: Wood for building; paper products; cotton, linen, and rayon for clothes; nitrocellulose for explosives; cellulose acetate for films.

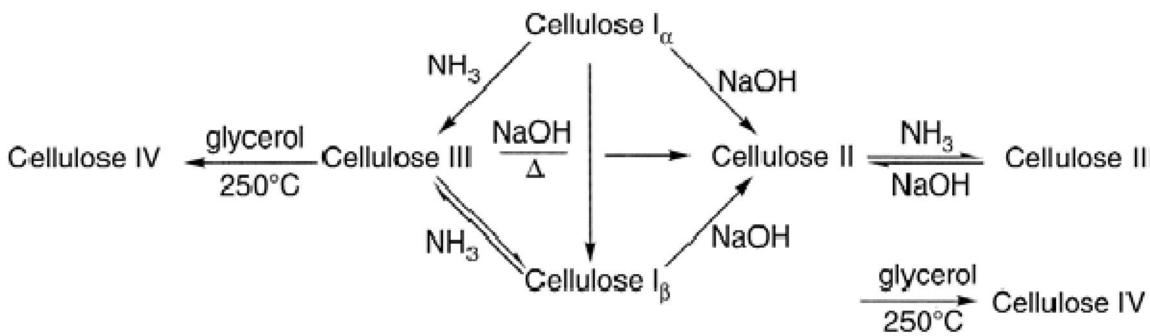
Cellulose is an excipient. Since plant polysaccharides comply with many requirements expected of pharmaceutical excipients such as non-toxicity, stability, availability and renewability they are extensively investigated for use in the development of solid oral dosage forms.

Cellulose It can be derived from a number of sources using a number of techniques that are considered synthetic and some that might be considered nonsynthetic (natural). It is available in many forms for different function Petitioned uses in food products include as a processing aid for filtration of juices, as an anti-caking agent ingredient for shredded cheese, and as a processing aid in the form of peel able hot dog casings. Various forms of cellulose have many other permitted FDA uses, including as a fat substitute and bulking agent in low calorie foods, as a texturizer, emulsifier, and extender.al purposes in food products& it obtained as a pulp from fibrous materials such as wood or cotton and although it was used in pharmaceutical applications such as a filler in tablets, it is microcrystalline cellulose that represents a novel and more useful cellulose powder, mainly used in the pharmaceutical industry as a diluent/binder in tablets.[9]

Cellulose is insoluble in water and most common solvents [6]; the poor solubility is attributed primarily to the strong intramolecular and intermolecular hydrogen bonding between the individual chains [5].

In spite of its poor solubility characteristics, cellulose is used in a wide range of applications including composites, netting, upholstery, coatings, packing, paper, etc. Chemical modification of cellulose is performed to improve process ability and to produce cellulose derivatives (cellulosic's) which can be tailored for specific industrial applications [10]. Cellulosic's are in general strong, reproducible, recyclable and biocompatible [11], being used in various biomedical applications such as blood purification membranes and the like.

Cellulose that is produced by plants is referred to as native cellulose, which is found in two crystalline forms, cellulose I and cellulose II [12]. CelluloseII, generally occurring in marine algae, is a crystalline form that is formed when cellulose I is treated with aqueous sodium hydroxide [13,14].Among the four different crystalline polymorphs cellulose I, II, III, and IV, cellulose I is thermodynamically less stable while cellulose II is the most stable structure. A liquid ammonia treatment of cellulose I and cellulose II gives crystalline celluloseIII form [15, 16], and the heating of celluloseIII generates cellulose IV crystalline form [17]. Figure 2 shows the transformation of cellulose into its various polymorphs [18].



DIFFERENT SOURCES FOR CELLULOSE:

1.Natural

2.synthetic

1. NATURAL FIBERS natural fibers are made from plant, animal and mineral sources. Natural fibers can be classified according to their origin.

Vegetable fiber

Vegetable fibers are generally composed mainly of cellulose: examples include cotton, jute, flax, ramie, sisal, and hemp. Cellulose fibers serve in the manufacture of paper and cloth. This fiber can be further categorized into the following:[20,21]

Category	Description	Examples	% of cellulose
Seed fibers	Fibers collected from seeds or seed cases	Cotton , kapok	90
Leaf fibers	Fibers collected from leaves.	Sisal, fique, agave.	33
Bast fibers Skin	Fibers are collected from the skin or bast surrounding the stem of their respective plants.	flax, jute, kenaf, Hemp, ramie, rattan, and vine fibers.	33
Fruit fibers	Fibers are collected from the fruit of the plant,	Coconut (coir) fiber.	30-50
Stalk fibers	Fibers are actually the stalks of the plant.	Rice, barley, wheat straws, bamboo ,grass, Tree wood	40-50

The most used vegetable fibers are - cotton, flax and hemp, although sisal, jute, kenaf, bamboo.

2. *SYNTHETIC FIBERS*

Synthetic or man-made fibers generally come from synthetic materials such as petrochemicals. But some types of synthetic fibers are manufactured from natural cellulose, including rayon, modal, and the more recently developed Lyocell. Cellulose-based fibers are of two types, regenerated or pure cellulose such as from the cupro-ammonium process and modified

Cellulose such as the cellulose acetates. [22]

Fiber classification in reinforced plastics falls into two classes:

1.Short fibers, also known as discontinuous fibers, with a general aspect ratio (defined as the ratio of fiber length to diameter) between 20 to 60

2. Long fibers, also known as continuous fibers, the general aspect ratio is between 200to 500.

Cellulose fibers

Cellulose fibers are a subset of man-made fibers, regenerated from natural cellulose. The cellulose comes from various sources. Modal is made from beech trees, bamboo fiber is a cellulose fiber made from bamboo, sea cell is made from seaweed, etc. Bagasse is cellulose fiber made from sugarcane.

Extraction procedures

Extraction from palm kernel cake using liquid phase oxidation. [23]

Hot water treatment is pretreatment step of cellulose extraction. Hot water treatment was performed in a micro-pressure reactor, which filled with 6 g of grinded PKC and 30 ml of distilled water. The reaction was heated to a temperature of 160-180°C, the reaction pressure increased rapidly up to saturated vapor pressure at the temperature. After 0.5 hour of hot water treatment, the reactor was soaked into cooling water in order to terminate the reaction. The pretreated PKC was washed with distilled water and ethanol to remove the organic acid and saccharides, then dried and sieved to 600 Em.

Liquid phase oxidation was then performed to remove the lignin from PKC and remain the pure cellulose. 2 g of pretreated PKC was mixed with 30% H2O2 by mixing ratio of 1-5, 1-7.5, and 1-10 of weight basis in a 100 ml flask with a tight plug. The flask with the reaction mixture was kept for 10-24 hours at temperature of 60-80°C. After the elapse of reaction time, an excess of cold water was added to the mixture to terminate the oxidation reaction [23]. The mixture was then filtered in order to separate the aqueous solution of organic compounds and solid residue.

The scheme of extraction stages for cellulose from palm kernel cake is shown in Fig3.

Dried and ground palm kernel cake.

⇩

Oil extraction.

⇩

. Oil free palm kernel cake.

⇩

Hot water treatment.

⇩

.Hemicelluloses-free palm kernel cake.

⇩

H_2O_2 liquid phase oxidation.

Extraction agricultural waste.[24]

1. Dried dhaincha, corn stalks, rice straw and wheat straw

2.formic acid treatment conditions 90% (v/v) formic acid concentration;- 120 min reaction time at boiling temperature.

3. Wash fibers with fresh formic acid.

4. Peroxyformic acid treatment - mixing 90% formic acid with 4% H_2O_2.

5. Bleaching pH was adjusted to 11, by adding (NaOH).

6. Hydrolysis 64% w/w sulphuric acid solution for 5 h at 45 °C, with constant stirring.

7. The resulting mixture was washed with cold water and repeatedly centrifuged.

8. The residue was then dried in a vacuum oven to constant weight for 48 hr.

Extraction from wood[25]

1.Weight no more than 100 mg of dry, finely ground plant tissue into a 2-mL eppendorf tube with locking cap

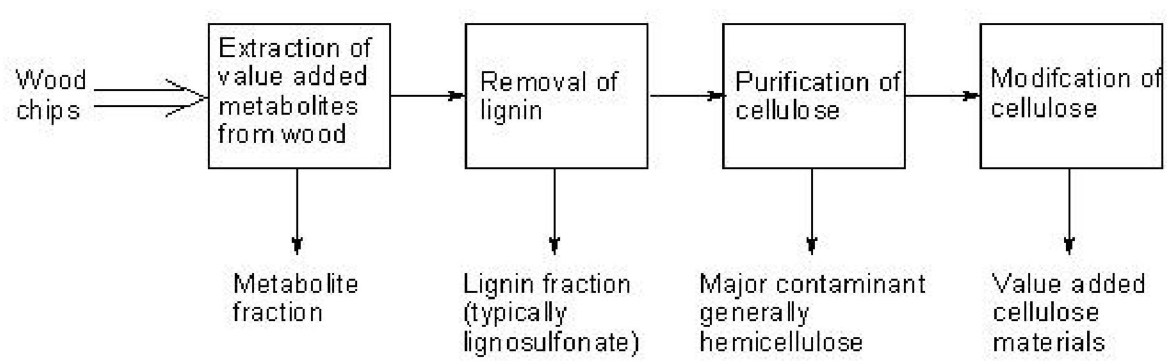
2. Add 1.00 ml of diethylene glycol dimethyl ether (diglyme) and 0.25 ml 10 M HCl.

3. Incubate in a water bath at 90°C for 60 min (longer OK). Samples should be shaken during incubation.

4. Cool, centrifuge and discard the supernatant.

5. Wash the pellet three times each with 1 ml methanol and 1ml hot DI water.

6. Dry the residue (80°C) and weigh into tin capsules



Extraction from cotton [26,27]

1. Pure cotton was weighed and transfer in round bottom flask, fitted with water condenser.

2.1N NAOH was added to round bottom flask and heated @105^{0}C for 1hr.

3. It subjected to bleaching using hydrogen peroxide.

4. It subjected to hydrolysis using 2.5N HCL.

5. Slurry was cooled and filtered.

6. The residue was dried in an oven @ 40^{0}C over night.

Extraction from bacterial pellicle [28]

1. Bacterial pellicle was thoroughly washed with water and cut in to small pieces.
2. Peices transferred in to round bottom flask and add 1N NAOH and heated @105^{0}C.
3. Product bleached with hydrogen peroxide.
4. It hydrolyzed using 2.5N HCL.
5. Mixture washed with distilled water and filtered.
6. The residue was dried in an oven @ 40^{0}C over night.

Benefits

Cellulose can be modified in many different ways to create new compounds that are useful in a variety of applications. The compound can be chemically altered to make the synthetic fiber called rayon which is used in clothing .it can also be adjusted to make cellophane, which is used to cover food to prevent spoilage.

Potential

Many of the properties of cellulose make it an attractive and more environmentally friendly alternative to oil and gas as a major source of fuel. The cost of creating cellulose and the lack of cellulose-related infrastructure such as fueling stations and vehicles that can use it, make it unlikely to overtake fossil fuels in the near future.

Chemical methods	**Reactants**	**Products**
Oxidation	Oxidizing agents, Gaseous chlorine, hydrogen peroxide, per acetic acid, chlorinedioxide,nitrogendioxide,persulf permanganate, dichromate-sulfuric acid, hypochlorousacid, hypohalites or periodates.ates,	Oxycellulose [29,30,31]
Micro crystallization	Nitric acid, nitroxide	Microcrystalline cellulose(MCC)[32,33,34] Silicified MCC
Etherification	Etherifying agents eg:methylchloride,ethyl chloride,ethyleneoxide,	Cellulose ethers methyl cellulose(MC),ethylcellulose(EC),hydroxyethylcellulose(HEC),hydroxypropylcellulose(HPC),carboxymethylcellulose[35,36]

	propyleneoxide,chloroacetic acid	
Esterification	Aceticacid, nitricacid, sulfuricacid, phosphoric acid.	Cellulose esters

Chemical modification of cellulose:

Oxycellulose

The oxidized cellulose fabric, such as gauze or cotton, resembles the parent substance

Description: it is insoluble in water and acids but soluble in dilute alkalis. In weakly alkaline solutions, it swells and becomes translucent and gelatinous. When wet with blood, it becomes slightly sticky and swells, forming a dark brown gelatinous mass.[37]

Application

1. It is used in various surgical procedures, by direct application to the oozing surface except when used for homeostasis.
2. It used in the development of variety of cosmetic, pharmaceutical, agricultural, and consumer products. Topical formulations (cream, lotion, or spray) prepared using the oxidized cellulose material, are bioadhesive, can be applied on the human skin or hair; can be included in cosmetics [38].
3. Oxidized cellulose dispersion uses in antiacne cream, anti-acne lotion, sunscreen sprays, anti-fungal cream also.

Limitation

It is not recommended as a surface dressing for open wounds [37].

Microcrystalline cellulose (MCC)

Description: Microcrystalline cellulose is a term for refined wood pulp and is used as a texturizer, a anti-caking agent, a fat substitute, an emulsifier, an extender, and a bulking agent in foods.[39] The most common form is used in vitamin pills or tablets. It is also used in plaque assays [40] for counting viruses, as an alternative to carboxymethylcellulose. Cellulose makes the ideal excipient. A naturally occurring polymer, it is comprised of glucose units connected by a 1-4 beta glycosidic bond. These linear cellulose chains are bundled together as micro fibril spiraled together in the walls of plant cell. Each micro fibril exhibits a high degree of three-dimensional internal bonding resulting in a crystalline structure that is insoluble in water and resistant to reagents.[41,42] There are, however, relatively weak segments of the micro fibril with weaker internal bonding. These are called amorphous regions but are more accurately called dislocations since micro fibril containing single-phase structure. The crystalline region is isolated to produce Microcrystalline Cellulose. [43, 44]

It is fine, white or almost white, odorless, free flowing crystalline powder.

It is Insoluble in water, ethanol, ether and dilute mineral acids. Slightly soluble in sodium hydroxide solution.

Applications:

1. Used as a emulsifier and stabilizer.

2. Used as anticaking and dispersing agent.

Silicified MCC

Silicified MCC (SMCC) is manufactured by co drying a suspension of MCC particles and colloidal silicon dioxide such that the dried finished product contains 2% colloidal silicon dioxide [45]. Silicon dioxide simply adheres to the surface of MCC and occurs mainly on the surface of MCC particles; only a small amount was detected in the internal regions of the particles. So, SMCC shows higher bulk density than the common types of MCC [46]. Also, tensile strength of compacts of SMCC is greater than that of the respective MCC [47] and it is most probably a consequence of intersurface interactions of silicon dioxide and MCC [48].

SMCC could be a suitable alternative excipient for direct- fill formulations for hard shell capsules [49].SMCC were easier to coat further also, the size and weight of individual tablets were decreased, which increases patients' compliance [50].

SMCC possesses further advantages, decreasing the hygroscopicity of the active ingredient (increased stability of tablets). Due to a decreased size, higher compressibility, and better flow properties (lower sensitivity to the rate of tableting); a larger number of tablets in one batch can be achieved, which makes their manufacture substantially cheaper [51]

Ethyl cellulose :

It is the cellulose ether prepared by reaction of alkali cellulose with ethyl chloride.

Description :

- Glass transition température is 120^0c
- It is characterized by the degree of ethoxy substitution and solution viscosity.
- It is water insoluble but solution in variety of organicsolvents/solvent mixture.
- The desired use of ethyl cellulose will determine the choice of à particular grade.
- It is tasteless and odorless, physiologically inert, stable in a pH range between 3 and 11.
- Becaue of its non ionic character it is compatible to most drug substances.
- It is used for coating of solid dosage forms, in matrix systems which are prepared by wet granulation or direct compression or in micro encapsulation.

- Excellent film forming properties.

Application :

1. Ethyl cellulose is one of the most widely used water insoluble polymers for the coating of solid dosage forms.
2. Ethyl cellulose can be incorporated as a carrier material into matrix preparation either by solution granulation or direct compression.
3. Ethyl cellulose microparticles can be prepared by various micro encapsulation process.
4. Used as a thickning agent and binder in tablets.
5. Ability of ethyl cellulose to sustain the release of drugs. [53-55]

Methyl cellulose :

It is the cellulose ether prepared by reaction of alkali cellulose with methyl chloride

Description : Methyl cellulose (or methylcellulose) is a chemical compound derived from cellulose. It is a hydrophilic white powder in pure form and dissolves in cold (but not in hot) water, forming a clear viscous solution or gel. Like cellulose, it is not digestible, not toxic, and not allergenic.

Methyl cellulose does not occur naturally and is synthetically produced by heating cellulose with caustic solution (e.g. a solution of sodium hydroxide) and treating it with methyl chloride. In the substitution reaction that follows, the hydroxyl residues (-OH functional groups) are replaced by methoxide ($-OCH_3$ groups). Different kinds of methyl cellulose can be prepared depending on the number of hydroxyl groups substituted. Cellulose is a polymer consisting of numerous linked glucose molecules, each of which exposes three hydroxyl groups. The *Degree of Substitution* (DS) of a given form of methyl cellulose is defined as the average number of substituted hydroxyl groups per glucose. The theoretical maximum is thus a DS of 3.0; however more typical values are 1.3–2.6. Different methyl cellulose preparations can also differ in the average length of their polymer backbones.

Applications:

1. It is used as thickener and emulsifier.[37]
2. It is used in treatment of constipation.
3. Methyl cellulose is used as variable viscosity personal lubricants.
4. Solutions containing methyl cellulose or similar cellulose derivatives are used as substitute for tears or saliva.
5. Methyl cellulose is used in the manufacture of capsules in nutritional supplements; its edible and nontoxic properties provide a vegetarian alternative to the use of gelatin.
6. Methyl cellulose can be employed as a mild glue which can be washed away with water.

7. Methyl cellulose is used as sizing in the production of papers and textiles as it protects the fibers from absorbing water or oil.
8. it is used to treat constipation, diverticulosis, hemorrhoids and irritable bowel syndrome[37]

Limitation

The commons side effect is nausea and the less common side effects are vomiting and cramp [55]

HPMC :

.**Description:** The pysicochemical properties of this substance strongly depend on the fallowing parameters

1. Methoxy content
2. Hydroxypropyl content
3. Mol weight

Grafting and cross-linkage HPMC are common methods to achive desired properties of the resulting polymers. The solubilty and swelling behavior of HPMC strongly depends on the molecular weight, degree of substitution, cross-linking and Grafting. Cross linked HPMC swells to some equal state at which the retroactive force of the network balance the swelling force

HPMC is water soluble cellulose ether and it can be used as hydrophilic polymer for the preparation of controlled release tablets. [56, 57]

Applications : [58,59]

1. HPMC is used in uncoated matrix systems and coated matrix systems.
2. This can also be used as polymer blends.
3. HPMC can be used in aqueous and solvent film coating.

Hydroxy ethyl cellulose :

Description : Hydroxy ethyl cellulose is a gelling and thickening agent derived from cellulose. It is widely used in cosmetics, cleaning solutions, and other household product. Hydroxy ethyl cellulose and methyl cellulose are frequently used with hydrophobic drugs in capsule formulations, to improve the drugs' dissolution in the gastrointestinal fluids. This process is known as "Hydrophilization"

Hydroxyethylcellulose is a non-ionic, water soluble polymer used as a thickening agent for aqueous cosmetic and personal care formulations. It will produce crystal clear gel products and thicken the aqueous phase of cosmetic emulsions. It can be also be used to efficiently thicken shampoos, body washes and shower gels. One of the problems normally associated with this and other water-soluble thickeners is the tendency of the particles to agglomerate or lump when first wetted with water. The high-purity cosmetic grade of Hydroxyethylcellulose we offer is an R-grade, designed to be added to water without lumping, and thus greatly facilitating solution preparation. It is also the most efficient grade of nonionic thickener available from the manufacturer.

Applications:

1. Used as an gelling and thickening agent.
2. Used in cosmetics(cleansing solutions, shampoos)
3. Used in textile and paper industry.
4. Used in film forming.
5. Used as an pesticide.

Hydroxy propyl cellulose:

Description: HPC is an ether of cellulose in which some of the hydroxyl groups in the repeating glucose units have been hydroxypropylated forming -OCH_2CH (OH) CH3 groups using propylene oxide. The average number of substituted hydroxyl groups per glucose unit is referred to as the degree of substitution (DS). Because the Hydroxypropyl group added contains a hydroxyl group, this can also be etherified during preparation of HPC.

Because cellulose is very crystalline, It is non-ionic water-soluble and pH insensitive cellulose ether. HPC has a combination of hydrophobic and hydrophilic groups, so it has a lower critical solution temperature (LCST) at 45 °C. At temperatures below the LCST, HPC is readily soluble in water; above the LCST, HPC is not soluble. HPC forms liquid crystals and many mesophases according to its concentration in water. Such mesophases include isotropic, anisotropic, nematic and cholesteric. The last one gives many colors such as violet, green and red. It can be used as thickening agent, tablet binding, modified release and film coating. [60, 61]

Application:

1. HPC used for artificial tears. It is used to treat medical conditions characterized by insufficient tear production such as keratoconjunctivitis sicca), recurrent corneal erosions, decreased corneal sensitivity, exposure and neuroparalytic keratitis.
2. HPC is also used as a lubricant for artificial eyes.
3. Used as a food additive.
4. HPC is used as a thickener, a low level binder and as an emulsion stabiliser. In pharmaceuticals it is used as a disintegrant and a binder in tablets.
5. HPC is used as a sieving matrix for DNA separations by capillary and microchip electrophoresis.

Carboxy methyl cellulose:

Description: Carboxymethyl cellulose (CMC) or cellulose gum is a cellulose derivative with Carboxymethyl groups (-CH_2-COOH) bound to some of the hydroxyl groups of the glucopyranose monomers that make up the cellulose backbone. It is often used as its sodium salt, sodium Carboxymethyl cellulose.

It is synthesized by the alkali-catalyzed reaction of cellulose with chloroacetic acid. The polar (organic acid) carboxyl groups render the cellulose soluble and chemically reactive. The functional properties of CMC depend on the degree of substitution of the cellulose structure (i.e., how many of the hydroxyl groups have taken part in the substitution reaction), as well as the chain length of the cellulose backbone structure and the degree of clustering of the Carboxymethyl substituent's.

Applications:

1. CMC is used in food science as a viscosity modifier or thickener, and to stabilize emulsions in various products including ice cream.
2. It is also a constituent of many non-food products, such as K-Y Jelly, toothpaste, laxatives, diet pills, water-based paints, detergents, textile sizing and various paper products.
3. It is used primarily because it has high viscosity, is non-toxic, and is hypoallergenic.
4. In laundry detergents it is used as a soil suspension polymer designed to deposit onto cotton and other cellulosic fabrics creating a negatively charged barrier to soils in the wash solution.
5. CMC is used as a lubricant in non-volatile eye drops (artificial tears). Sometimes it is methyl cellulose (MC) which is used, but its non-polar methyl groups ($-CH_3$) do not add any solubility or chemical reactivity to the base cellulose.
6. CMC is also used in the oil drilling industry as an ingredient of drilling mud, where it acts as a viscosity modifier and water retention agent. Poly-anionic cellulose or PAC is derived from CMC and is also used in oilfield practice.
7. Insoluble micro granular Carboxymethyl cellulose is used as a cation-exchange resin in ion-exchange chromatography for purification of proteins.
8. CMC is also used in ice packs to form a eutectic mixture resulting in a lower freezing point and therefore more cooling capacity than ice.

Sodium Carboxy methyl cellulose:

Croscarmellose Sodium is a cross linked polymer of Carboxymethyl Cellulose Sodium. Cross an insoluble, hydrophilic, highly absorbent material, resulting in excellent swelling properties fibrous nature gives it excellent water wicking capacities. Croscarmellose Sodium provides dissolution and disintegration characteristics, thus improving bioavailability of formulation. In biomedicine it has been employed for preventing postsurgical soft tissue and epidural scar adhesions. [62, 63].

Applications:

1. Croscarmellose Sodium is used in oral pharmaceutical formulations as a disintegrant for and Granules. In tablet formulations Croscarmellose Sodium may be used in both direct-compassion and processes.
2. Fine filming properties.

3. Better thickening and binding properties.
4. Used in textile and paper industry.
5. Act as a protective colloid to reducing water losses.
6. Used as an insecticides
7. Used in oil well drilling operations.
8. Denture adhesives Shampoos, foamed products Syrups, Toothpaste Bulk laxatives Ointments, creams, lotions Jellies, salves.[63- 65]

Conclusion

Cellulose is versatile polymer used in pharmaceutical application obtained from different sources. Chemical modification of cellulose is performed to produce cellulose derivatives (cellulosic's) which are in general strong, low cost, reproducible, recyclable and biocompatible, so they can be tailored for pharmaceutical applications. Cellulose derivatives are often used to modify the release of drugs in tablet and capsule formulations and also as tablet binding, thickening and rheology control agents, for film formation, water retention, improving adhesive strength. MCC is used as diluent and disintegrating agent for release oral solid dosage. HEC and HPC are used in hydrophilic matrix systems, while EC can be used in hydrophobic matrix system.

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