Cellulose and derivatives for pharmaceutical applications

OFCA, the Organisation des Fabricants de produits Cellulosiques Alimentaires, is the global not-for profit association for the regulated grades of cellulose derivatives used in food, feed, pharmaceutical, personal care and food contact products. The association represents the major global manufacturers of cellulose derivatives.

OFCA products are derived from high purity cellulose, sourced from sustainably managed wood or cotton plantations. The structure that is most widely accepted for the cellulose molecule is a chain of β anhydroglucose units joined together by acetal linkages. These long, oxygen-linked anhydroglucose-unit chains have great strength, which is passed on to the cellulose derivatives. The properties of flexibility and toughness in these derivatives are directly attributable to this long-chain structure. Each anhydroglucose unit has three replaceable hydroxyl groups, all or part of which may be substituted during the reaction to manufacture the different cellulose derivatives.

Due to the difference in the substituents (such as methyl, hydroxyethyl and hydroxypropyl) and the difference in the degree of substitution (the amount of substituted substance of reactive hydroxyl in each cellulose), cellulose derivatives of different varieties and grades can be obtained, each with unique properties and providing varying functionalities. Although sharing a cellulose backbone, these variations make it difficult, if not impossible, to extrapolate the application of analytical test methods between the different cellulose derivatives.

The following information is intended to illustrate the structural and functionality differences between the cellulose derivatives that are used for pharmaceutical applications.

Microcrystalline Cellulose
Compendial name: Microcrystalline cellulose
Cellulose backbone, β-linked units of D-Glucose
Solubility: Insoluble in water and ethanol
Appearance: Fine, white or almost white, odourless, free flowing crystalline powder.
Functionality: Tableting agent

Powdered Cellulose
Compendial name: Powdered cellulose
Cellulose backbone, β-linked units of D-Glucose
Functionality: Tableting agent. Purified, mechanically disintegrated cellulose prepared by processing alpha cellulose obtained as a pulp from fibrous plant materials; occurs as a white, fibrous particle which may be compressed into self-binding tablets which disintegrate rapidly in water.

Ethyl Cellulose
Compendial name: Ethylcellulose
Cellulose backbone, β-linked units of D-Glucose, partly substituted with Ethyl groups
Solubility: Insoluble in water
Functionality: coating agent for tablets

Methyl Cellulose
Compendial name: Methylcellulose
Cellulose backbone β-linked units of D-Glucose, partly substituted with Methyl groups
Solubility: Soluble in cold water
Functionality: Methylcellulose is used as a tablet and capsule disintegrant, a tablet binder, and as a viscosity-increasing agent.

Hydroxypropyl Cellulose
Compendial name: Hydroxypropylcellulose
Cellulose backbone β-linked units of D-Glucose, partly substituted with Hydroxypropyl groups
Soluble in water and inorganic solutions

Hydroxypropyl Methyl Cellulose
Compendial name: Hypromellose
Methyl Cellulose, partly substituted with 2-hydroxypropyl groups
Functionality: Emulsifier, Stabilizer, Thickening agent

Carboxymethyl Cellulose
Compendial name: Carmellose
Cellulose backbone, β-linked units of D-Glucose, partly substituted with carboxymethyl groups
Solubility: Forms a suspension in water. Insoluble in Ethanol.

Sodium salt of Carboxymethyl Cellulose
Cellulose backbone, β-linked units of D-Glucose, partly substituted with carboxymethyl groups
Compendial name: Carmellose Sodium
Soluble in water
Functionality: Thickening agent, Stabilizer

Calcium salt of Carboxymethyl Cellulose
Cellulose backbone, β-linked units of D-Glucose, partly substituted with carboxymethyl groups
Compendial name: Carmellose Calcium
Insoluble in water
Functionality: disintegration agent

Sodium salt of cross-linked Carboxymethyl Cellulose
Crosslinked cellulose backbone, β-linked units of D-Glucose, partly substituted with carboxymethyl groups
Compendial name: Sodium Cross Carmellose
Insoluble in water
Functionality: disintegration agent

Note:
Carmellose is a generic name used for pharmaceutical applications of derivatives of Carboxymethyl Cellulose (free acid). Chemically these cellulose derivatives are structurally related, the common backbone being a carboxymethyl substituted cellulose polymer. The corresponding functionalities however are very different which makes it difficult, if not impossible, to extrapolate the application of analytical methods between cellulose derivatives carrying the generic name of carmellose.