

# **Carbohydrates**

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# DEFINITION

*“A **carbohydrate** is an organic compound which consists only of carbon, hydrogen, and oxygen, with a hydrogen: oxygen atom ratio of 2:1.”*

*A **carbohydrate** has an empirical formula  $C_m(H_2O)_n$  (where  $m$  could be different from  $n$ ).*

# **FUNCTIONS IN PLANT**

*Plants store starch in roots, tubers, and leafy parts, mainly during photosynthetic activity; some plants, such as sugar beets and sugarcane, also store sucrose.*

*Carbohydrates function as the main **structural elements** in plants, in two forms: cellulose and hemicelluloses.*

*Carbohydrates serve as **storage products of energy**. The principal forms are starch in plants. These are polymers of glucose; they are deposited in cells in the form of granules when a surplus of glucose is available. In times of metabolic need, when the body is exerting itself, the polymers are broken down by enzymatic action and become fuel.*

# Carbohydrates

## Sucrose/ sucrose drugs

Sucrose

Dextrose

Liquid glucose

Fructose

Lactose

## Cellulose/Cellulose derivatives

Purified cotton

Powdered cellulose

Microcrystalline  
cellulose

Methyl cellulose

Sodium CMC

## Gums & mucilage

Tragacanth

Acacia

Sodium alginate

Agar

Pectin

# **Gums and Mucilage**

# Introduction

	<b>Gums</b>	<b>Mucilages</b>
<b>Properties</b>	Gums are amorphous translucent substances which are insoluble in alcohol & most organic solvents. These are soluble in water & give a viscous, sticky solution.	
<b>Occurrence</b>	Gums are commonly found in trees & shrubs.	Mucilage is often found in epidermal leaf cells, seed coats, roots, barks etc.
<b>Constituents</b>	Gums consist of Ca, Mg & K-salts of polyuronides.  Sugars i.e. monosaccharides (mainly galactose, arabinose, xylose) and uronic acids.	
<b>Formation</b>	Gums are abnormal products, formed by injury of the plant due to unfavourable conditions (e.g. drought), or breakdown of cell wall.	Mucilages are generally normal products of metabolism formed within the cell (intracellular formation).
<b>Functions</b>		Storage Protection for germinating seeds

# AGAR

## **Source:**

*Agar is a gelatinous substance derived from a polysaccharide that accumulates in the cell walls of agarophyte red algae primarily from the genera Gelidium and Gracilaria, or seaweed (Sphaerococcus euchema).*

*For commercial purpose, it can be obtained from Gelidium amansii and Gelidium cartilaginum.*

## **Collection:**

*Algae is collected in the summers, spread on beach and bleached in sun.*

*In winters, it is extracted by using boiling water. A mucilaginous liquid is separated by a cloth which is then cooled and jelly is cut into strips. It is sun dried.*

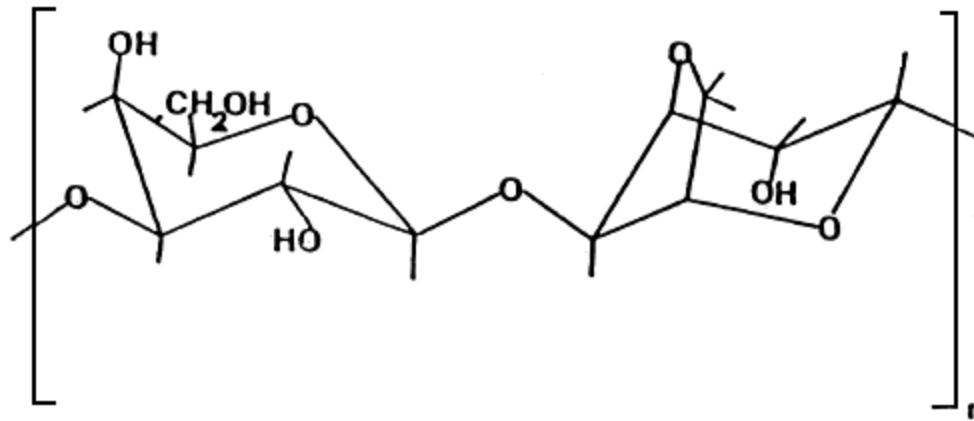
*Water from the jelly is removed by drying it at 35°C. Agar block is crushed and reduced to fine powder.*





## Structure:

*Agar consists of a mixture of agarose and agaropectin.*



## Uses:

- ☀ *Impression material in dentistry*
- ☀ *Suspending and emulsifying agent*
- ☀ *Tablet disintegrant*
- ☀ *Encapsulating substance*
- ☀ *Nutrient media for bacterial cultures*
- ☀ *Laxative*

# PECTIN

## **Source:**

*Pectin is a purified product obtained from inner part of rind of citrus fruits.*

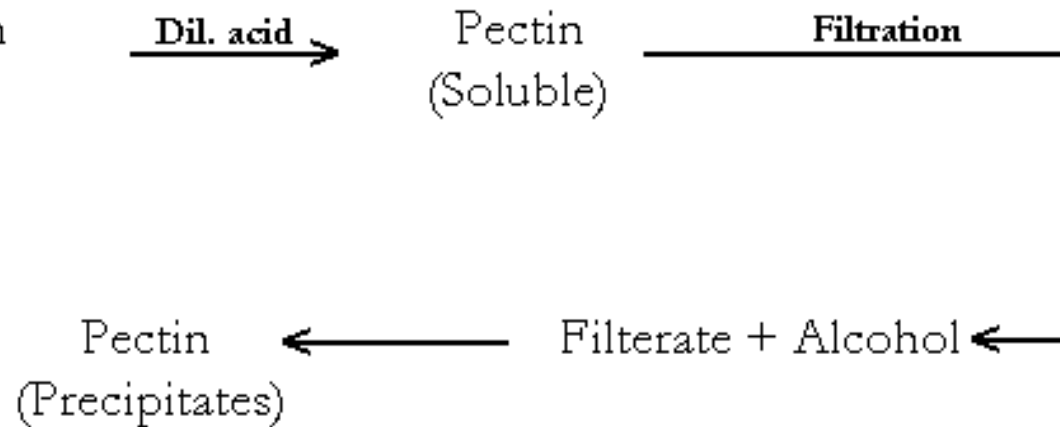
*It may also be  
Obtained from;*

- \* Papaya*
- \* Gentian*
- \* Mangoes*



## **Collection:**

*It occurs in the middle lamella of cell wall, in an insoluble form i.e. protopectin.*






## **Constituents:**

*Pectin is a complex polysaccharide, consisting of;*

- \* D- galacturonic acid*
- \* D- galactose*
- \* L- rhamnose*
- \* L- arabinose*

## **Uses:**

-  *Treatment of diarrhea*
-  *Gelling agent*
-  *Emulsifying agent*

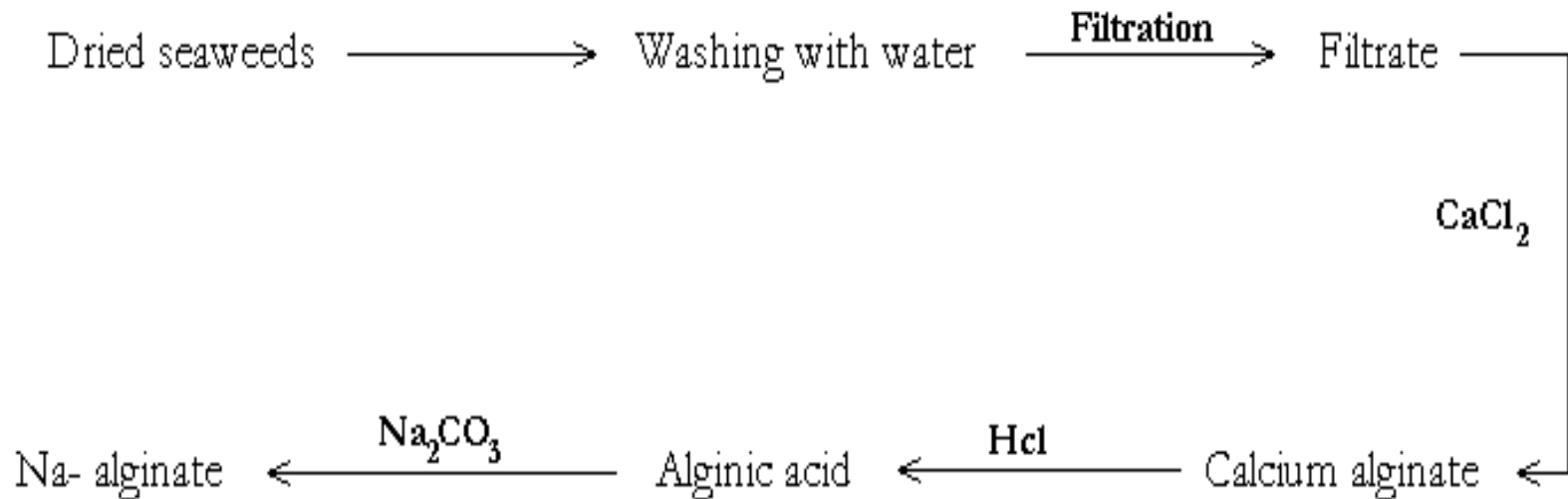
# SODIUM ALGINATE

## **Source:**

*Sodium alginate is the purified carbohydrate product extracted from *Macrocystis pyrifera* by using dilute alkali.*



## ***Preparation:***







## **Constituents:**

*It consists of alginic acid.*

*Alginic acid is composed of;*

- \* Mannuronic acid*
- \* Glucuronic acid*

## **Uses:**

-  *Suspending agent*
-  *Emulsifying agent*
-  *Stabilizing agent*
-  *Tablet binders*



# ACACIA

## **Sources:**

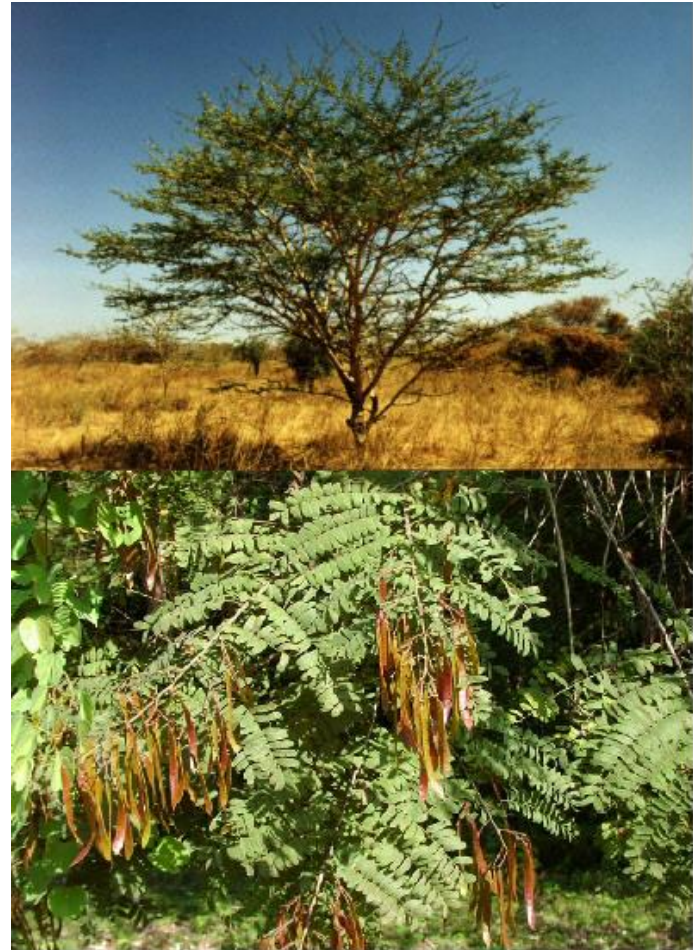
*Acacia arabica*  
*Acacia senegal*

## **Family:**

*Leguminosae*

## **Part used:**

*Dried gummy exudates from  
stem*





## **Collection:**

*On the bark, a transverse incision is made and cambium is exposed. Within a month, phloem cells are produced in cambium. Gum tears are formed on this and these are collected in leather bags.*

*For bleaching, gum is exposed to sun for 3-4 months. Cracks are formed on the outer surface of gum tears. Finally tears are graded based on external appearance and packed.*

## **Constituents:**

- *Calcium, magnesium and potassium salts of arabic acid*
- *Arabic acid, upon hydrolysis, yields arabinose and galactose*

## **Uses:**

- ✓ *Demulcent*
- ✓ *Emollient*
- ✓ *Tablet binder*
- ✓ *Suspending agent*
- ✓ *Emulsifying agent*

# TRAGACANTH

## **Sources:**

*Astragalus gummifer*

## **Family:**

*Leguminosae*

## **Part used:**

*Dried gummy exudate  
obtained from incision  
to stem*



## **Collection:**

*Gum is produced in the plant cell by a process called gummosis. It is a process in which pith and medullary rays of cell wall are converted into gum.*

*Incision is made on stem and gum is obtained as a soft solid mass. When exposed to air, water in the gum evaporates, and gum is dried.*

## **Constituents:**

- *Water soluble component “tragacanthin”*
- *Water insoluble component “bassorin”*
- *Polysaccharides (Arabinose and Lactose)*
- *Starch*
- *Cellulose*
- *Water*

## **Uses:**

- ✓ *Suspending agent*
- ✓ *Emulsifiers*
- ✓ *Stabilizer*
- ✓ *Emollient*
- ✓ *demulcent*

# **CELLULOSE AND CELLULOSE DERIVATIVES**

# PURIFIED COTTON

**Source:**

*Gossypium hirsutum*

**Part used:**

*Seed hair*



## **Production:**

*Capsules of plant are called bolls. These consist of numerous seeds and hairs attached with seed coat. When ripen, bolls are collected. Hair are separated from seeds. Hairs contain various impurities and oil globules. Raw cotton is put in sodium hydroxide solution and then washed with water. Bleaching is done by means of chlorinated lime. After bleaching, cotton is washed and dried.*

## **Uses:**

*\* Surgical purposes*



# CELLULOSE

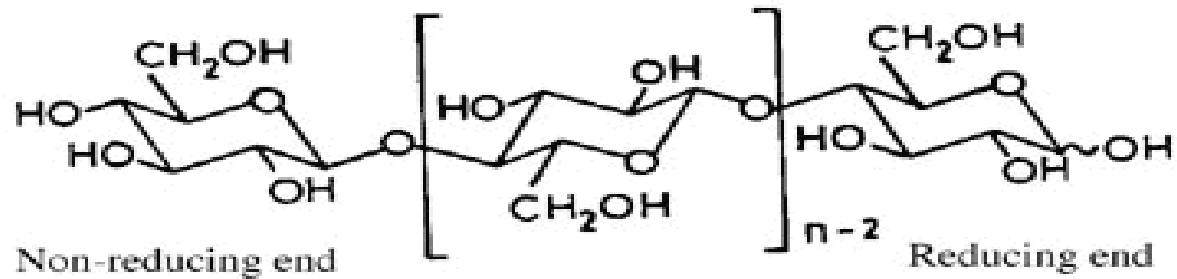
## **Source:**

*Cellulose is the structural component of the primary cell wall of green plants, many forms of algae and the oomycetes. Some species of bacteria secrete it to form biofilms. About 33% of all plant matter is cellulose (the cellulose content of cotton is 90% and that of wood is 40–50%).*

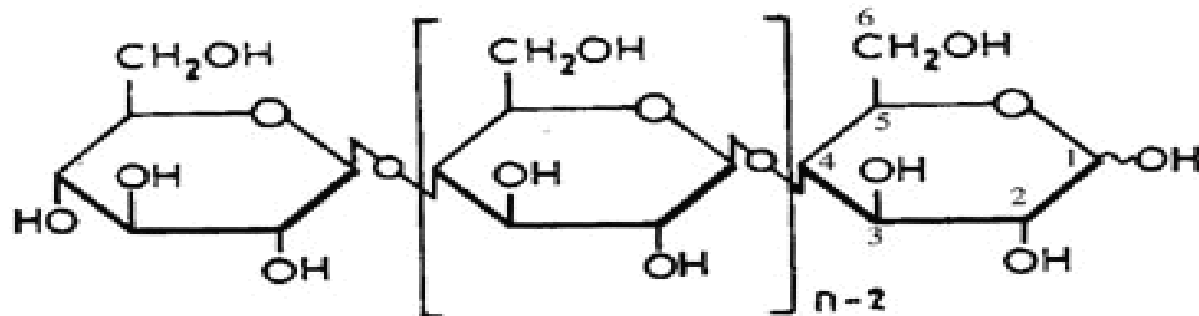
*For industrial use, cellulose is mainly obtained from wood pulp and cotton.*

# Constituents:

*Cellulose is a polysaccharide consisting of a linear chain of several hundred to over ten thousand  $\beta(1\rightarrow4)$  linked D-glucose units.*



OR



# METHYL CELLULOSE

*Methyl cellulose is a derivative of cellulose.*

*It is a hydrophilic white powder in pure form and dissolves in cold water, forming a clear viscous solution or gel.*

*It is used as;*

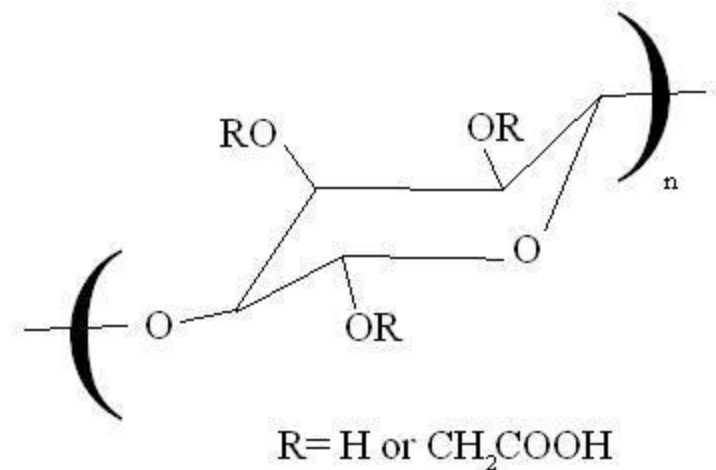
- ✿ *Lubricant*
- ✿ *Thickener*
- ✿ *Emulsifier*

# CARBOXY METHYL CELLULOSE

*Carboxy methyl cellulose (CMC) also called cellulose gum, is a cellulose derivative.*

*It contains carboxy methyl groups (-CH<sub>2</sub>-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 carboxy methyl cellulose.*



## **Synthesis:**

*It is synthesized by the alkali-catalyzed reaction of cellulose with chloroacetic acid.*

## **Uses:**

*It is used as;*

- ✿ Viscosity modifier*
- ✿ Stabilizer*
- ✿ Cation exchange resin in ion exchange chromatography*

# CELLULOSE MICROCRYSTALLINE

*Microcrystalline cellulose* refers to refined wood pulp.

*It is used as;*

- ✓ *An anti-caking agent, an extender, bulking agent in food production.*
- ✓ *The most common form is used in **vitamin supplements** or tablets.*
- ✓ *It is also used in **plaque assays** for counting viruses, as an alternative to carboxy methyl cellulose.*
- ✓ *It is used as **diluent** in pharmaceutical preparations.*

# **SUCROSE AND SUCROSE DERIVATIVES**

# HONEY

## **Zoological origin:**

*Apis mellifera*

## **Family:**

*Apidae*

## **Description:**

*It is a saccharine secretion deposited in the honey comb by bee.*





## **Constituents:**

- ✿ *Dextrose*
- ✿ *Fructose*
- ✿ *Sucrose*
- ✿ *Volatile oils*
- ✿ *Pigments*
- ✿ *Pollen grain*

## **Uses:**

- ✿ *Nutrient*
- ✿ *Sweetener*
- ✿ *Demulcent*

# CARAMEL

## **Source:**

*Sugar*

## **Preparation:**

*Caramel is obtained by heating glucose or sugar with alkali, alkaline carbonate or a trace of mineral acid until sweet taste of sugar is destroyed and uniform dark brown mass is formed.*

## **Uses:**

*Coloring agent*

# XYLOSE

## **Source:**

*Straws*

*Corn cobs*

## **Preparation:**

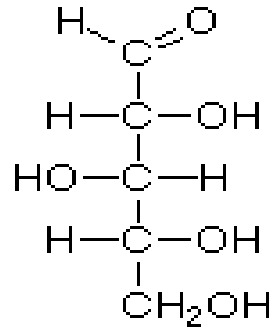
*Xylose is obtained by boiling corn cobs, straws or other such material with dilute acid i.e. Hcl , to hydrolyze the xylan polymer which is broken down to yield xylose.*

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## Structure:



## Uses:

*Diagnostic agent disorders due to intestinal malabsorption.*

*For example;*

- Crohn's disease*
- Radiation enteritis*

*– Pellagra*

# LIQUID GLUCOSE

## ***Botanical origin:***

*Zea mays*

## ***Family:***

*Gramineae*

## ***Preparation:***

*Liquid glucose is prepared by controlled hydrolysis of starch.*

## **Constituents:**

- *Dextrose*
- *Dextrin*
- *Maltose*
- *Water*

## **Uses:**

- *Sweetening agent*
- *Tablet binder*
- *Tablet coating agent*
- *Diluent*

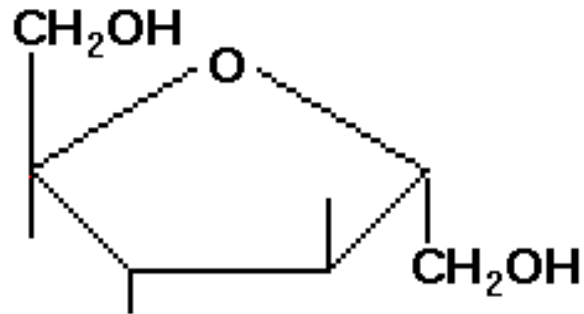
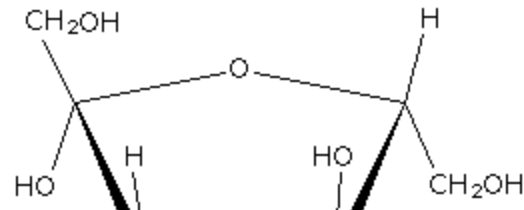
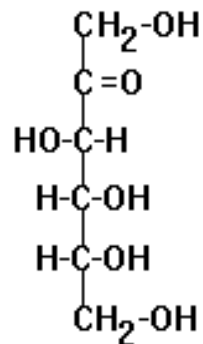
# FRUCTOSE

## Source:

*Fructose can be obtained from;*

- *Honey*
- *Sweet fruits*
- *Inulin*

## Structure:



## **Preparation:**

*It is obtained by inversion of aqueous solution of sucrose and subsequent separation of fructose from glucose. When sucrose is hydrolyzed, glucose and fructose are obtained in equal quantities.*



## **Uses:**

- *Electrolyte replenisher*
- *Fluid nutrient*



# SUCROSE

*Sucrose, a non-reducing sugar, is major product of plant photosynthesis.*

## **Sources:**

*Sugar cane (*Saccharum officinarum*)*

*Sugar beet (*Beta vulgaris*)*

*Sugar maple (*Acer saccharum*)*



## ***Preparation:***

### *(i) Sugar beets*

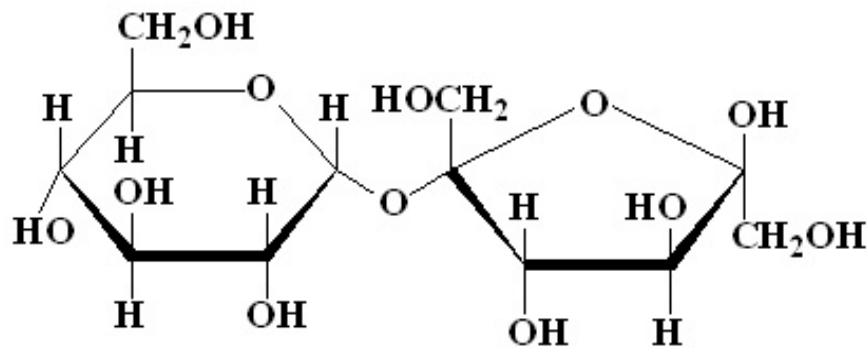
*Beets are dug, washed and sliced into small, limp slices known as “cossettes”. Sucrose and other soluble constituents are extracted from plant material with hot water. Crude sugar containing solution is subjected to purification purpose.*

### *(ii) Sugar cane*

*stems of sugar cane are crushed between series of heavy iron rollers. It is boiled with lime to neutralize plant acid. Boiling is done to coagulate albumin.*

*Coagulated albumin rises to the top as scum and is removed. Juice is filtered. It is sometimes decolorized with sulphur dioxide, concentrated and crystallized.*

**Structure:**



## ***Uses:***

- ✿ *Sweetening agent*
- ✿ *Preservative*
- ✿ *Demulcent*
- ✿ *Nutrient*
- ✿ *Anti- oxidant*
- ✿ *Coating agent*

# LACTOSE

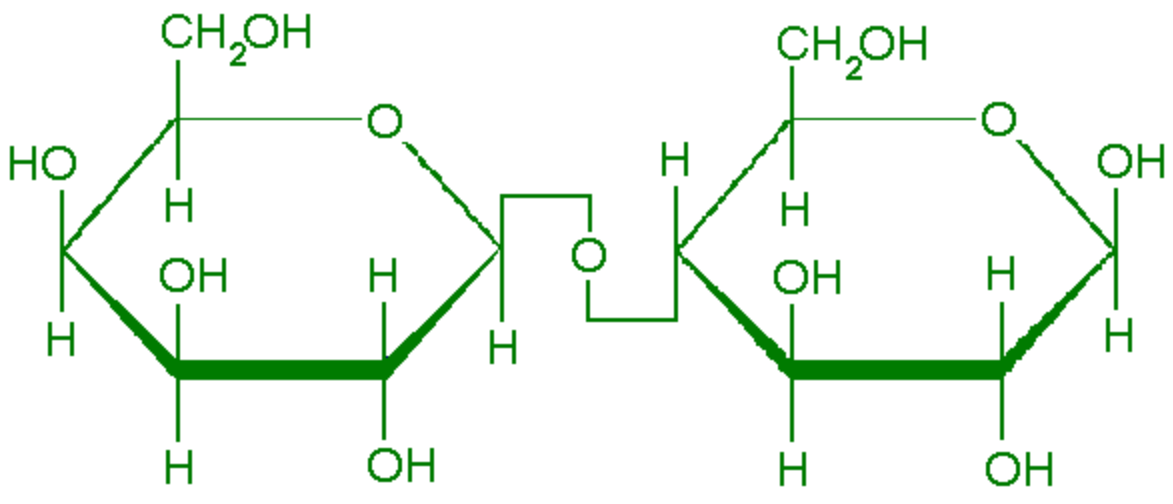
## **Source:**

*Milk of Bos taurus*

## **Preparation:**

*Whey is source of lactose. Lactose is crystallized from whey. Impure crystals are redissolved in water. Charcoal is added to decolorize. Recrystallization gives lactose.*

**Structure:**



**Uses:**

- *Tablet diluent*
- *Tablet binder*
- *Nutrient*

# DEXTROSE

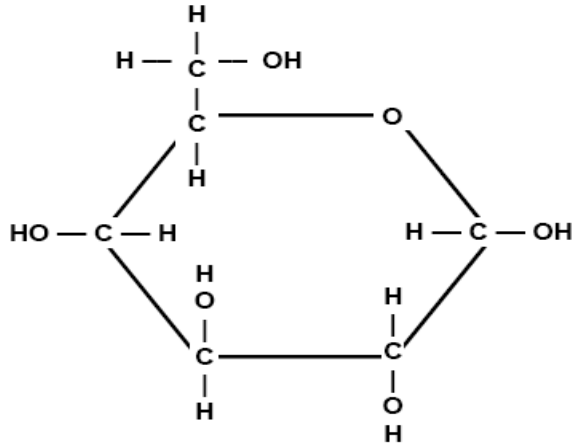
## **Source:**

- *Grapes and other fruits*
- *It can be obtained by hydrolysis of certain natural glycosides.*

## **Preparation:**

*Commercially, dextrose is obtained by controlled hydrolysis of starch.*

# Structure:



# Uses:

- *Nutrient*
- *Part of anti-coagulant solution*
- *Sweetening agent*
- *Tablet binder*
- *Coating agent*



# INULIN

## Sources:

- ✿ *Inula helenium*
- ✿ *Coneflower Echinacea spp*
- ✿ *Taraxacum officinale*
- ✿ *Dioscorea spp*
- ✿ *Helianthus tuberosus*
- ✿ *Allium cepa*
- ✿ *Allium sativum*
- ✿ *Arnica montana*

## Uses:

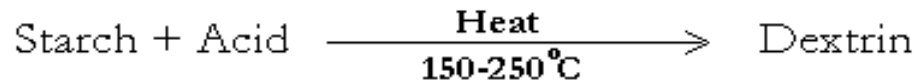
- *Fermentative identifying agent for bacteria*
- *Lab evaluation of renal function*

# DEXTRIN

## Sources:

- ✿ *Maize*
- ✿ *Potato starch*

## Preparation:



## Uses:

- *Nutrient*
- *Adhesive for surgical dressing*
- *Binder*
- *Thickening agent*

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# STARCH

## Sources:

*Maize (Zea mays)*

*Wheat (Triticum turgidum)*

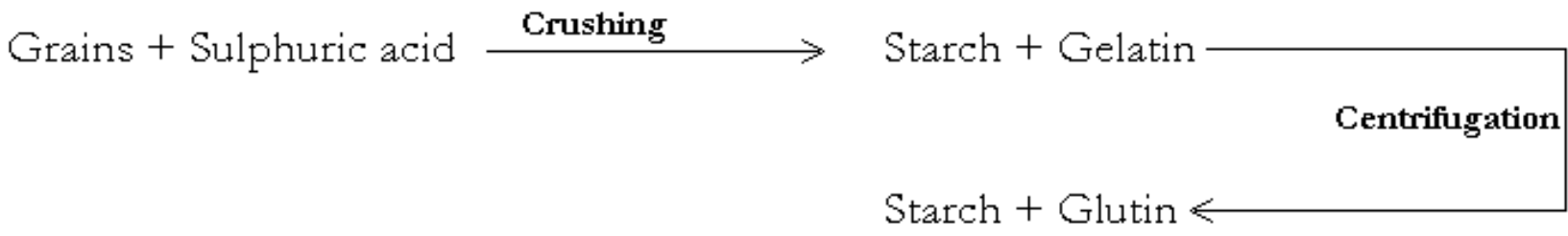
*Potato (Solanum tuberosum)*

*Rice (Oryza sativa)*

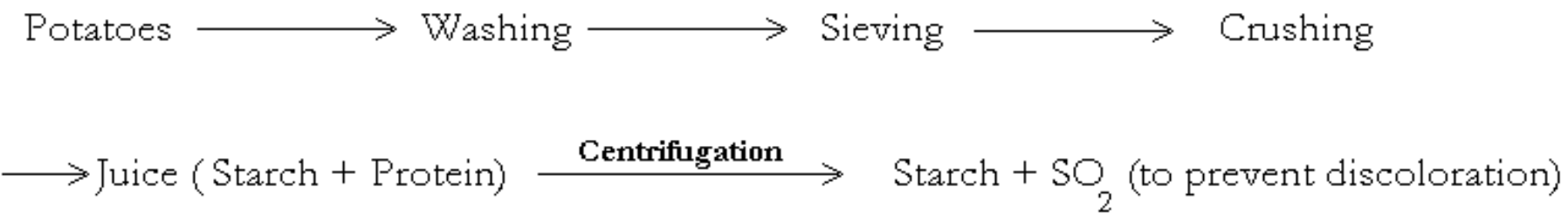


# Preparation:

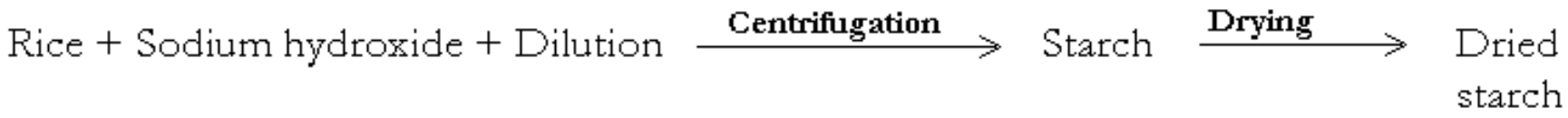
## Maize



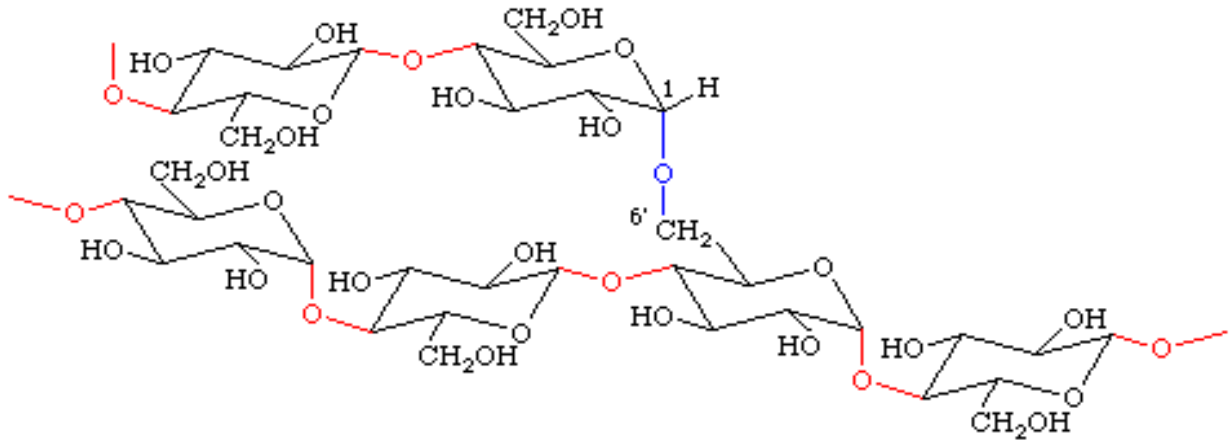
## Potato



## Rice



# Structure:



# Uses:

- *Tablet disintegrant*
- *Absorbent*
- *Binder*
- *Emollient*
- *Antidote in codeine poisoning*

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