RAMSADAY COLLEGE

Amta, Howrah-711401, West Bengal

Semester IV
CC9
Topic-4

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Semester-4 CC-9

Sugar and starches: Morphology and processing of sugarcane, products and byproducts of sugarcane industry.

MORPHOLOGY

S. officinarum, the sugarcane plant, is a perennial rhizomatous giant grass with a thick solid aerial stem 3 to 8 m tall and usually 3.8 to 6.0 cm in diameter (Figure 4.1). Canes measuring up to 12.8 m in height have been recorded and are often propped with bamboo stakes. It grows in clumps (stands). The colour of the cane ranges from almost white to yellow to deep green, purple-red or violet. The stem is joined, the joints being shorter at the base, gradually increasing both in length and thickness upward until a maximum is reached beyond which they become progressively smaller and finally terminate in an inflorescence. A cane joint consists of five conspicuous parts: a). a node–the area where the leaf sheath is attached to the stem; b). the root band composed of several rows of minute translucent dots–the root initials or root primordia; c). the intercalary meristem, a narrow meristematic zone just above the root band that is responsible for the growth of the internode d). the internode–a barrel-shaped structure covered with a fairly thick waxy bloom and e). the lateral buds placed alternately on opposite sides of the stem and protected from damage by the leaf sheath that forms a tight covering around the internode (Figure 4.2 A).

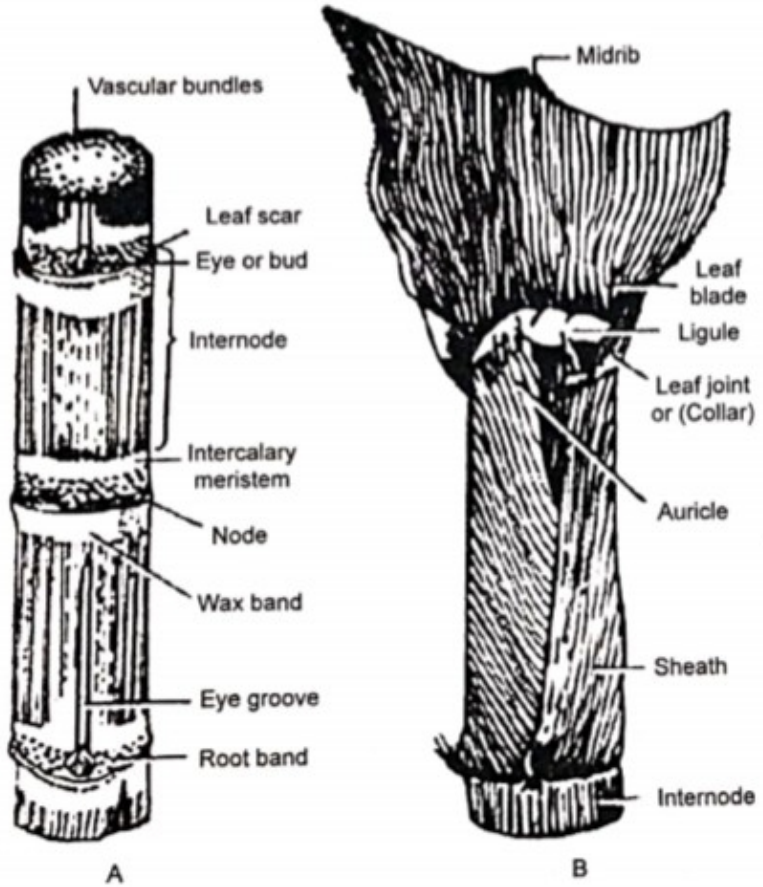


Figure 4.2 Diagram of (A) a piece of cane stalk consisting of two complete joints and part of two adjacent joints; (B) structure of the leaf.

Anatomically, the hard outer part of the stem (rind) is composed of several layers of thick-walled lignified cells that afford protection to the underlying cells. Internally, it consists of soft light-coloured tissues (pith) in which numerous fibrovascular bundles are embedded. The parenchyma cells

MANUFACTURE OF SUGAR

Harvested cane is quite perishable (the sugar being liable to undergo inversion into glucose and fructose) and, therefore, should always be sent to a nearby sugar mill without any loss of time. The process of manufacturing white crystalline sugar from cane involves the following steps:

- *Extraction of juice:*

  The freshly cut cane stalks are shredded into small pieces with the help of crushers and then passed through heavy, grooved steel rollers to squeeze out the juice. Several successive expressions are required to ensure complete extraction of the juice. After each expression, the cane is moistened by sprays of water to facilitate a complete recovery. The material left behind is called 'bagasse'. The expressed juice is a turbid, dark-greyish sweet fluid full of impurities such as organic acids, minerals, proteins, colloidal colouring matter, gums, pieces of cane and other extraneous material.

- *Purification of juice:*

  The juice is first strained to remove as much as possible of the insoluble and suspended particles, and is thereafter subjected to defacation, carbonation and sulphitation to completely remove the dissolved non-sugars. During defacation, the juice is heated with measured amount of lime to remove free organic acids and phosphates as insoluble calcium salts. The proteins and colloidal colouring matter are removed from the solution as a thick scum appearing on the surface. Filteration removes the precipitated calcium salts and the scum through the canvas. The filtered juice is then led to tanks where it is allowed to come in contact with carbon dioxide (carbonation), a process which removes excess lime as calcium carbonate and also brings about decomposition of calcium sucrate into soluble black sugar. During sulphitation, the filtered carbonated juice is treated with sulphur dioxide to complete the neutralisation of lime and the decomposition of calcium sucrate.

Flow chart 1

- *Concentration and crystallisation:*

  The purified juice is now led to evaporators where it is boiled under reduced pressure until it becomes a thick syrup. Partial vacuum boiling also prevents darkening and decomposition of sugar.

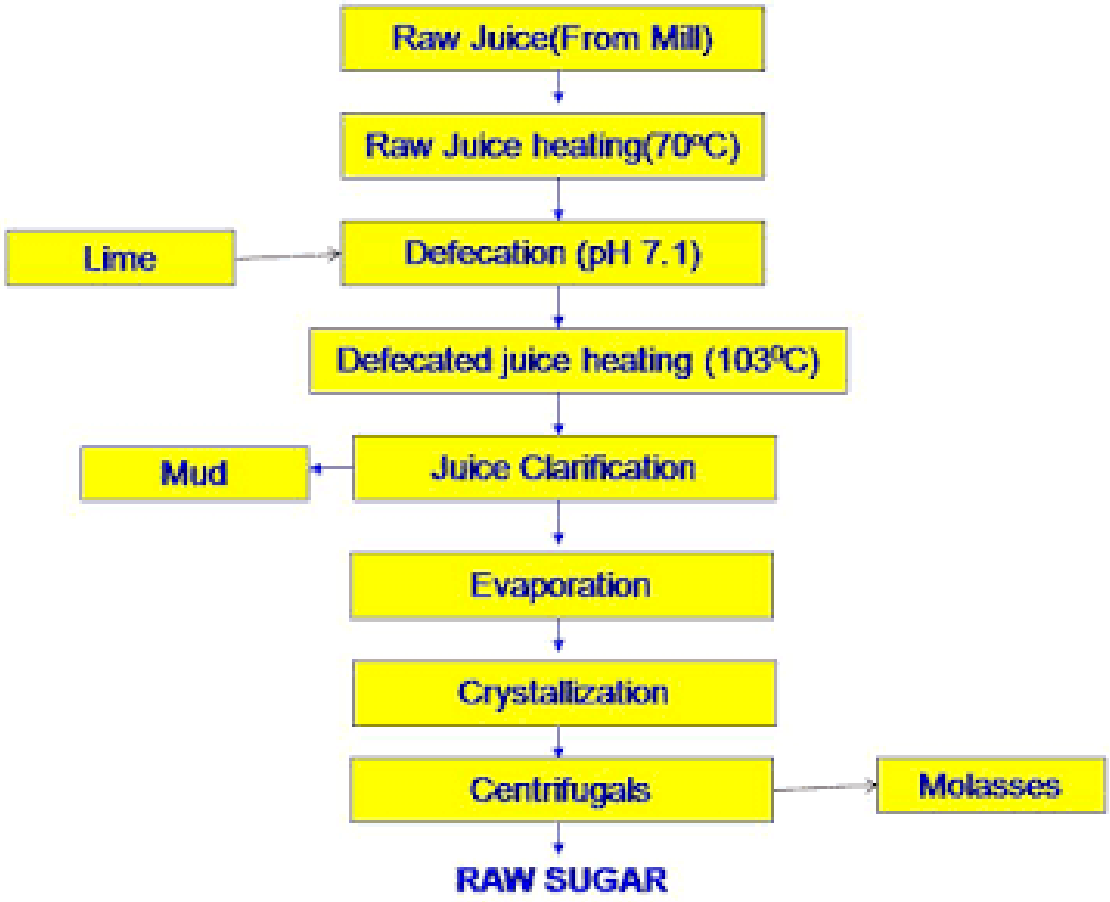
  The concentrated raw syrup is finally boiled in a vacuum pan to the point of crystallisation to produce a thick sticky mass (massecuite) in which a part of the sugar is thrown out in the form of crystals. This dark brown mixture of sucrose crystals and mother liquor (molasses) is next stirred in open tanks, or 'crystallisers' until it crystallises. Finally the massecuite is led into centrifugal machines, an operation during which the molasses passes through the screen and the crude sugar is retained in the basket from where it can be removed after a quick washing with water. The molasses still contain some crystallisable sugar and is mixed with the raw syrup and boiled. The step is repeated three to four times to remove as much sugar as possible.

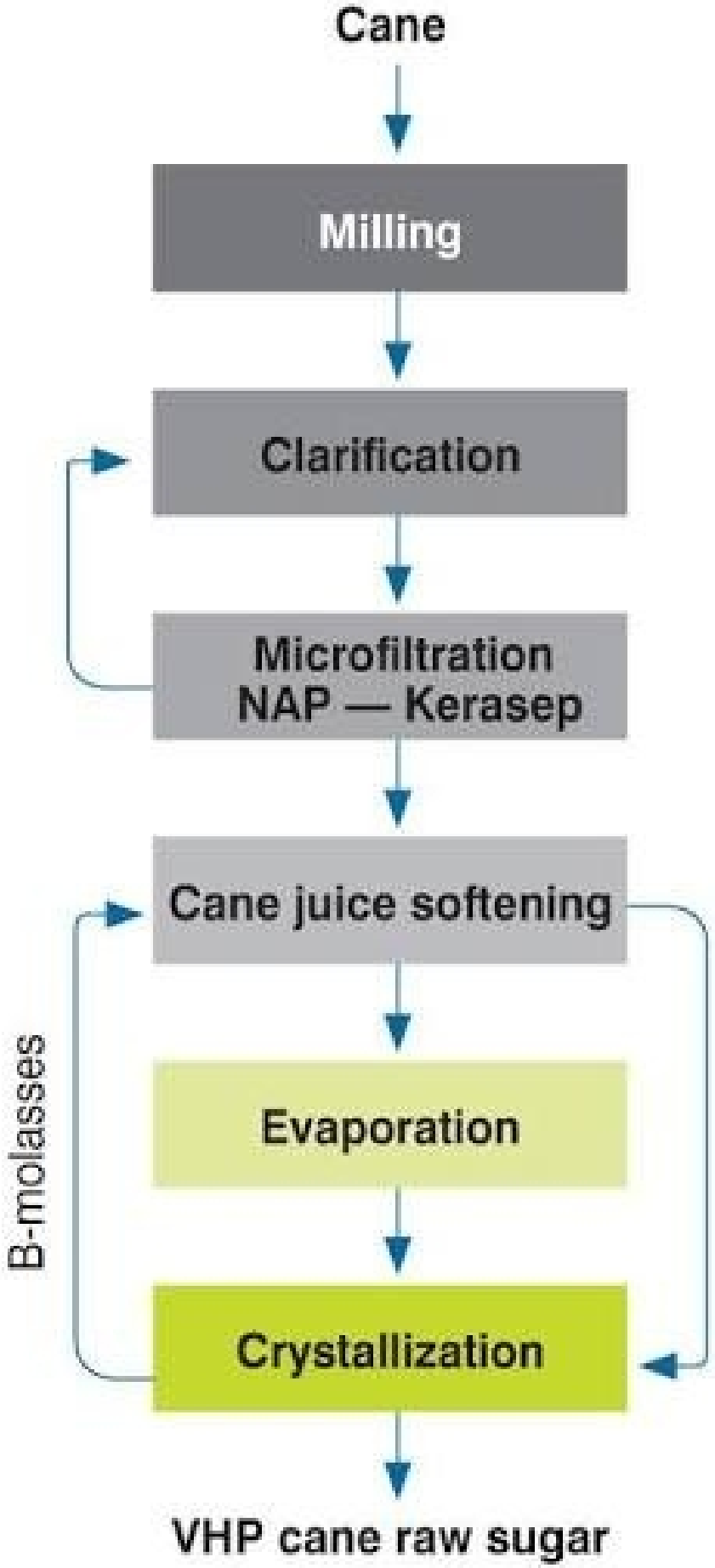
  The centrifugal raw sugar is reddish brown or somewhat greyish in colour and contains about 96 per cent sucrose. It is usually exported in this form, further refining being done in the importing country.

- *Refining and drying of crystal:*

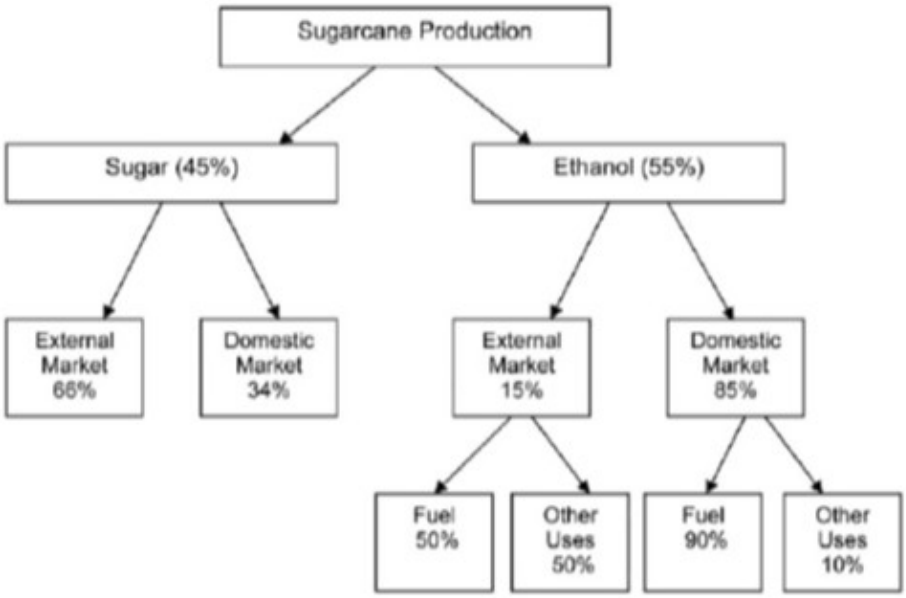
  The raw sugar is redissolved in hot water and the suspended impurities are removed by adding diatomaceous earth. The solution is decolourised to a colourless sparkling liquid by treating with carbon black. The clear syrup, after vacuum concentration, is centrifuged so that pure sparkling white crystal of sugar separate out. The crystals are then dried in large rotary driers in the presence of a strong current of hot air. The dried granulated sugar crystals are now passed across inclined vibrating screens to be graded according to size and are shipped for export after packaging.

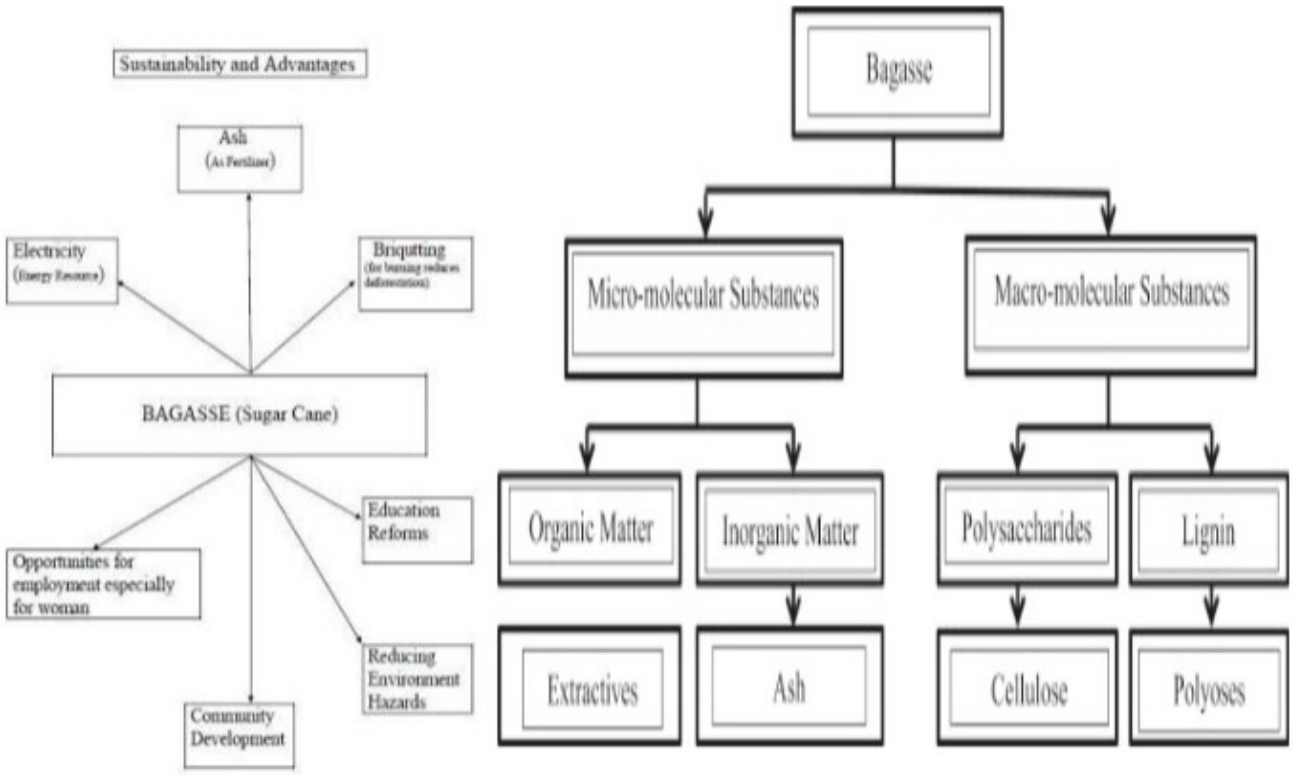
Simple Flow chat for raw sugar process




Cane
Milling
Clarification
Microfiltration
NAP — Kerasep
Cane juice softening
Evaporation
Crystallization
B-molasses
VHP cane raw sugar

Products and byproducts of sugar cane





By-products of sugarcane production