

# POST HARVEST PROCESSING





## *Sugar Processing Toolkit*



## **POST HARVEST PROCESSING**

### **1.- Sugarcane - General information**

Sugarcane is the name given to a grass plant of the *Saccharum* gender, from which the *Saccharum officinarum* L is the most important species. The most important part of the sugarcane plant are the stalks, because sugars and other substances accumulated by the sugarcane during its growth are found in it.

Sugarcane should present a number of both technological and production characteristics, which define its quality and affect its processing. When elaborating the products, the applied techniques are not able to minimizing the effects from the low-qualified raw material nor increasing the productivity.

The ideal sugarcane characteristics for the production of muscovado, "rapadura", and sugarcane syrup are as follows: high sucrose concentration (measured by Brix); low content of fibers, ashes, mineral elements, and nitrogen compounds; to show none or low blossoming; to be resistant to the incidence of diseases and pests; does not produce lateral sprouts; and its straw to be easily removed. When cut is performed, the easiness of straw removal is important, since burning is not recommended and there are environmental legislation to control this matter. It is also important that just before maturation those varieties presenting high blossoming index to be avoided, because they lose their sugar while increasing the amount of fibers, therefore impairing the industrial production. It is recommended to work just with ripe sugarcane and mainly with high maturation uniformity. A high maturation index implies low variation in sugar content (Brix) between the inferior and superior parts of the sugarcane stalk.

The main component of the sugarcane juice in the production of muscovado, sugarcane syrup, and rapadura is sucrose. The sugar content (sucrose) in the ripe sugarcane depend from the some factors, such as climate conditions, soil fertility, fertilization quality, cultural tracts, sugarcane variety, and sugarcane plantation age, among others.

The ideal temperature for cropping the sugarcane is around 25 °C, under air humidity conditions from 70% to 80% and pluviometric regimes above 1000mm annually. Although the occurrence of rain throughout the year and the high air humidity rather favor the sugarcane vegetation, they also hinder its maturation. Thus, there is a need for choosing regions where the dry periods are longer for obtaining a sugarcane with higher sucrose content. The sandy soils favor the maturation of sugarcane, by making possible the obtainment of a raw material with higher sugar content. Those soils that are irrigated, loamy, and with high level of organic matter tend to delay the maturation. The sugarcane composition is a function of several factors, from which the main ones are: varieties, age and sugarcane sanity, as well as the climatic conditions, incidence of pests and diseases, application of fungicides and insecticides, and so on.

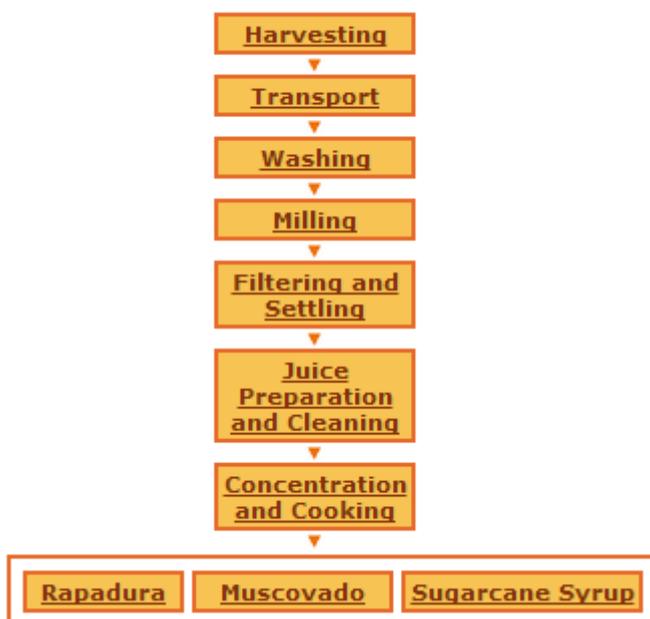
When controlling the production, the relationship of sucrose kilogram yielded by each hectare is prioritized in detriment to tons of sugarcane by hectare. Before planting the sugarcane, the producer should search for information on varieties more adapted to his region as well as to accomplishing the soil analysis aiming at either acidity correction, when this is the case, and the best fertilization formula. <BR

The producer should pay attention to the following parameters and their respective values before the industrialization of sugarcane: juice Brix ( 18%), Pol ( 15%) and reducing sugars (1%). Brix expresses the percent soluble solids of the sugarcane juice, that mainly consists of sucrose, glucose, fructose, mineral salts and nitrogen substances. Therefore, it expresses the maturation condition of the sugarcane because more than 90% sugar contained in the juice from the ripe sugarcane is sucrose.



## 2.-Sugarcane Post Harvesting System

### Sugarcane Post Harvesting System



## **2.1.-Harvesting**

Sugarcane should be cut when it reaches the peak maturation, with a maximum content of sucrose and minimum of simple sugars (reducers). These reducing sugars do not crystallize during the sugar or "rapadura" processings, therefore prejudicing their production, besides affecting the flavor (sensorial quality) of the products. For sugarcane syrup, however, they do not constitute a technological problem. Visually, the sugarcane maturation peak for harvesting can be determined, based on three aspects: sugarcane size; uncovered or leafless stalks; three-quarters of the leaves are already dry, yellowish and/or fell down. During the production process, the manipulator will not succeed in giving the point to the concentrated juice in order to make the "rapadura" and muscovado.

For the production of "rapadura" and muscovado, it is recommended not taking advantage of the top of the sugarcane because the juice from this part is rich in reducing sugars (glucose and fructose) that cause problems, such as: excessive darkening of "rapadura" and sugar mass; difficulty to obtaining the reference point; stickiness during storage; and worse performance over processing. For sugarcane syrup, however, the sugarcane top may be used in spite of containing some substances that impairs the clarification of the syrup during the production of this product.

## **2.2.-Transport**

It may be accomplished in motorized vehicles (trucks and vans) or with animal traction (bulls, horses, asses, etc). The vehicles must be clean to avoid impurities such as dirt and stones to contaminate the sugarcane, nor endanger the quality of the juice and the grinding efficiency. The sugarcanes should be cut and transported to the mill in order to be ground, preferentially at the same day they were cut.

## **2.3.-Washing**

This stage is optional. In the case it is accomplished, the drinking water must be used. This stage helps to reduce the contamination of the juice by dirt, straw, and other strange materials. The straw contribute to an increase in the volume of the fiber to be processed during juice extraction.

## **2.4.-Milling**

The main objective of sugarcane milling is the extraction of the juice from the sugarcane. This stage occurs in equipment so-called mills. The cut and clean or yet washed sugarcane passes through rollers of the milling equipment, where the extraction of the juice occurs and a fibrous by-product so-called bagasse is the leftover. The sun-dried bagasse is the fuel to be burned for the obtainment of thermal energy to be used in concentration of the sugarcane juice.

The mill or the juice extracting mill should be always well lubricated, regulated and friezed, since this maintenance is indispensable to obtain good performance of the equipment, energy economy and durability of the equipment.

The feeding of the sugarcane in the mill should be as uniform as possible. Irregularities in the feeding will cause losses in extraction capacity. The following factors affect the milling capacity:

a) sugarcane preparation - if it is chopped before passing through milling equipment, the milling capacity is increased and the extraction of the juice may also be increased;

- b) sugarcane variety - it is related to the amount of fiber in the ripe sugarcane - the more is the fiber, the minor will be the capacity to extract the juice;
- c) dimensions and speed of the milling rollers;
- d) pressure of the rollers on the sugarcane and bagasse;
- e) operator – the operator's training may involve higher production, higher work safety and lower accident risks.

## **2.5.-Filtering and Settling**

The broth in a settling must be placed so that coarse impurities presents in the broth settle, separating them. In this way, these are removed by the deep one, and the light ones stay in the top. The filtration has as objective to remove these light impurities that stay in the top. For this, a filter of coarse mesh is used (07 mesh). This stage is of extreme importance because it allows the work with cleaner broth of sugarcane, contributing for the attendance of the quality requirements. Also, if carried through well, eliminates it necessity of one second settling in the manufacture of the sugarcane syrup one.

## **2.6.-Preparation and cleaning of the juice**

The normal sugarcane juice has a pH around 5.7. In case it is below this value, it is necessary to correct the acidity in order to avoid an excessive darkening of the product, besides the excessive inversion of sucrose, which is harmful in the case of both muscovado and 'rapadura' production. This correction is accomplished in the juice destined to the production of those two products; in the case of sugarcane syrup, this operation is not necessary.

Correction is accomplished, by adding the milk of lime to the cold juice or during heating, when juice is at the range temperature of 55°C to 60°C. The milk of lime is slowly added to the cold juice, then this juice is vigorously agitated. The milk of lime is prepared, by extinguishing the CaO (calcium oxide or quicklime) in water. The CaO added to a low water volume and the obtained suspension are sieved and added to the juice. The CaO should have a purity content between 85 and 95%. The calcium hydroxides available in construction material stores cannot be used, since they have additives that cannot be present in alimentary products. One way to follow-up this operation is using the pH-indicating paper (litmus paper). Juice samples are taken from the large bowl, then the red litmus paper is immersed into them. It must be manipulated with clean and dry hands, without soap residues, so that no interference occurs into result. Other ways to verifying the pH of the healthy juice are: titration with an alkaline solution (NaOH) or (KOH) or the pH determination by PH-meter (potentiometer).

The pH correction is important because:

- a) it approximates the juice pH to 5.7(natural pH of the sugarcane juice), therefore hindering the inversion of sucrose and warranting a higher production of both sugar and "rapadura";
- b) it increases the precipitation of the phosphorus compounds and calcium compounds, so improving the quality of the juice;
- (c) it draws other impurities of the juice during precipitation of those phosphorus compounds.

The cleaning of the juice is one of the most important phases in the productive process, since the appearance of the product is a factor that leads the consumer to buy it. The cleaning of the

juice or the removal of impurities under the form of foams are made under heating. The juice heating should be slowly performed in order to allow for complete flotation of the lightest substances. A soft ebullition might occur, but not a vigorous one because the floating substances can be reincorporated into juice. When beginning the heating of the sugarcane juice, there occurs the formation of foams containing impurities such as gums, greases and waxes, that together with the pectic acids and some nitrogenous substances will form the so-called organic solid of the juice (non-sugars).

In the foam, are also found some dyeing matters (pigments) such as the chlorophyll, anthocyanin and saccharetin besides solid fragments. This foam removal is performed, by using a skimmer. These impurity removals guarantee a clearest and purer product, and should be accomplished during the concentration operation.

## **2.7.-Concentration and Cooling**

The juice is poured into large bowls, where it will be warmed. As boiling goes on, the juice must be constantly stirred until becoming concentrated – at the end it can reach up to 92°Brix, depending on the product. During this phase, a consistent foam will appear on the surface of the juice. This foam contains some impurities that must be removed. The qualities of the sugar, 'rapadura' and sugarcane syrup will depend on the efficiency of the clarification work (juice cleaning) accomplished at this phase.

The cooking end of the may be verified through several practical alternatives, and one of them is the toffee proof which consists of removing approximately 50 mL from the syrup undergoing concentration and pouring it into a vessel with cold water. By handling with the fingers, the syrup turns cold and becomes a candy from which the desirable consistence depends on the product under manufacturing: muscovado or "rapadura".

The concentration temperature of the syrup and its final Brix vary as a function of the final product. For muscovado, the temperature ranges from 114°C to 120°C and Brix from 88 to 90. For "rapadura" however, the temperature ranges from 110°C to 114°C and Brix from 86 to 88. The variation for muscovado is 106°C to 108°C and Brix at the range from 70 to 75. For sugarcane syrup at a Brix above 75, some sugar crystals will appear at the bottom of the recipient in which it was packaged.

## **3.- Care to be taken at the concentration stage**

- a) To always work with ripe sugarcane: juice with high sugar content and free from impurities;
- b) To always work with recently cut sugarcane – the sugarcane must be processed until 24 hours after cutting it;
- c) To accomplish the correction of the juice acidity;
- d) To promote an efficient cleaning throughout the heating and concentration phases of the juice;
- e) To prevent the presence of insects and any other animals in the facilities and neighborhoods of the plant in order to avoid the contamination of the product by strange material;
- f) To always keep the hygiene and cleaning of the plant facilities;
- g) To promote the training and the plant workers' training and consciousness about the needs for cleaning, personal hygiene, as well as cleaning and sanitizing of all equipment and utensils;

- h) To maintain the heat distribution uniformity in the syrup concentration equipment;
- i) To reduce the heating of the syrup when approaching the final desired Brix, in order to avoid thermal damages to the product as well as to allow for getting the right point.



#### **4.- Special Safety Cares**

As the production of these products involves operations in that the temperatures are high, it is recommended that the operators work with gloves, apron of impermeable material and small boots. With that broth splashes and hot syrup and consequent burns can be avoided. And important that the equipments allow a better handling of the operations. The use of extinguishers of fires is now a demand.

#### **5.- Quality Control**

Quality is considered as the group of characteristics that differentiate the individual product units and are important for determination of this unit acceptability level by the buyer/consumer. The quality must be throughout the environment of the production system - in other words, since choosing the sugarcane varieties, the area and soil for planting, cutting and transportation of the sugarcane, facilities and cares during all production operations, safety of the labor or staff until the product to be acquired by the consumer. In fact, even beyond this point, when consumer is advised for the best way to using the product. All personnel involved in this production should be conscious and have knowledge about what quality is. When the product lot is referred as a qualified one, it means that its characteristics of taste, aroma, flavor, color, as well as the indicators for microbiological and physiochemical qualities are within the specification limits (tolerable and appropriate for the product), as defined by local legislation or by the consumers.

The manufacturer should be attentive to both production and productivity indicators as well as to several intermediate indicators during the processing. Some simple measures such as temperature, Brix by decimeter or by refractometer are extremely useful in controlling the production process. The artisanal producers need to learn about these analyses. For most sophisticated analyses, some laboratory networks are available in public and private institutions to supply this service. The quality control should be understood as a group of arrangements or actions accomplished during production, processing, storage and commercialization of the product, searching to keep the quality at those levels the consumer (buyer) will accept, which will satisfy their needs, as including the prevention of risk to the health.

#### **Raw material quality attributes**

The sugar content in the sugarcane juice: this parameter affects the industrial production. It may be estimated through either soluble solids (°Brix), by using instruments so-called refractometers. Sugarcane pH: the average pH is around 5,5. Strange matter: they might be from vegetable or mineral origin; the one from vegetal origin is constituted of sugarcane straw

and weeds, whereas that from vegetal origin is the earth. These impurities should not be transported to the industries, because they can endanger the quality of the final products.