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Sweet sorghum syrup production offers farmers an excellent opportunity to improve farm income and productivity. Ideally suited for the small landowner with limited capital, this crop requires only 1 to 3 acres. Sweet sorghum yields 200 to 300 gallons of syrup per acre, and sorghum syrup sells for $15 to $20 per gallon. A recent budget estimated that total fixed and variable costs are approximately $800 per acre. So, net profits of over $2,500 per acre are possible.

The marketing outlook for sorghum syrup is also very favorable. Almost all the sorghum syrup produced is sold within 2 months after it is processed. Sorghum syrup is generally unavailable from December through August. So, even if syrup production is increased several-fold, a ready market will be available.

The Sweet Sorghum Plant

Sweet sorghum, or “sorgo,” is closely related to other sorghum crops. It differs from grain sorghum mainly in that its grain yields are low and its stalks are taller and juicier and have a high sugar content. It reproduces by seed and produces tillers, but it has no rhizomes. It is a perennial grass under tropical conditions, but it is winter-killed in areas where frost occurs. Some sweet sorghum varieties are grown for syrup production, while others are grown for forage (silage).

Adaptation

Sweet sorghum is adapted to widely differing climatic and soil conditions. Although grown from Alabama to Minnesota, it is grown most extensively in the southeastern states.

Sweet sorghum is a warm-season crop that matures earlier under high temperatures and short days. It tolerates drought and high-temperature stress better than many crops, but it does not grow well under low temperatures.

It is not demanding in its soil requirements and can be grown on soils ranging from heavy clay to light sand. Loam and sandy loam soils generally allow the best syrup production. Good soil drainage is important for good performance.

It is not necessary to grow sweet sorghum on sandy, low-fertility soils in order to produce a high-quality syrup. High-quality syrup can be made from sweet sorghum grown on a wide range of soil types.

Varieties

Variety selection is an important decision in sweet sorghum production. Improved varieties have been developed in recent years at the United States Sugar Crops Field Station near Meridian, Mississippi. Seed of older varieties originating at other places may still be available in some areas. Important varieties are described below.

RECOMMENDED VARIETIES

Dale is a mid-season variety developed at the U.S. Sugar Crops Field Station. Seed are small, reddish brown, and germinate well. Dale is resistant to leaf anthracnose and red stalk rot. Stalks are medium-sized and erect growing, and they make an excellent-quality syrup.

M8IE is a late-maturing variety which matures a few days later than Dale. It was released from the U.S. Sugar Crops Field Station, Meridian, Mississippi. It is similar to Dale in height and lodging resistance. M8IE is resistant to leaf anthracnose and red stalk rot, but it is susceptible to maize dwarf mosaic. The yield of syrup from M8IE is generally superior to Dale. The syrup has a mild sorghum flavor, amber color, and excellent quality. It appears to be more susceptible to a light frost than the other varieties.

Brandes was released in 1968 from the U.S. Sugar Crops Field Station. It is a late-maturing
variety with an excellent root system and stiff stalks that usually remain erect. It is resistant to leaf anthracnose and red stalk rot. It has good syrup quality, but it is more susceptible to drought than some varieties. The seed are small and white and have good germination.

**Theis** is a variety developed at the U.S. Sugar Crops Field Station, Meridian, Mississippi, and released in 1974. It has late maturity similar to Brandes and Wiley. This variety may grow to 12 to 16 feet tall, but it has good lodging resistance. This produces large, brown seed. Syrup quality is usually excellent. It is highly resistant to leaf anthracnose and red stalk rot, has moderate resistance to downy mildew, and is tolerant to maize dwarf mosaic virus.

Seed for recommended varieties can be obtained from:

MAFES
Mr. Bennie C. Keith
P. O. Box 6311
Mississippi State, MS 39762-6311.

**Other Varieties**

**Sugar Drip** is an early mid-season variety of unknown origin. It tends to lodge and is very susceptible to many diseases. Seed are medium-sized and brown. This variety is one of the earliest-maturing varieties for the South, and so it is useful for early syrup production. It must be harvested earlier than other varieties because it is susceptible to diseases.

**Georgia Blue Ribbon**, a variety of uncertain origin, lodges badly and is susceptible to major sweet sorghum diseases. Stalks are shorter and juicier than those of Tracy. Syrup quality is excellent. The seed are medium-sized and brown. It matures about the same time as Tracy.

**Honey** is a variety grown by the USDA before 1900; it is also called Honey Drip and Texas Seeded Ribbon. The stalks grow 7 to 10 feet tall and tend to lodge badly. It yields well and makes excellent-quality syrup, but it is susceptible to most major sorghum diseases. It is a few days later than Tracy in maturity.

**Tracy** is a mid-season variety developed by the U.S. Department of Agriculture and released in 1953. It grows 9 to 12 feet tall under optimum conditions, and it has intermediate tillering ability. The stalks are erect and juicy. The syrup quality can be excellent, but under some conditions the juice may contain too much starch for proper boiling. Tracy is susceptible to anthracnose, red rot, zonate leaf spot, and rust. It yields a high tonnage of stalks, but the syrup yield per ton of stalks is low.

**Fertilization And Liming**

Like other crops, sweet sorghum needs adequate nutrients to produce good yields. Fertilization practices may also affect syrup quality. Soil testing should be used to determine the need for lime, phosphorus, potassium, calcium, and magnesium.

Sweet sorghum is one of the most sensitive crop plants to acid soils. Before planting sweet sorghum, make sure that the soil pH is greater than 5.8.

Excessive nitrogen reduces syrup quality. So, recommended amounts of nitrogen should not be exceeded, and all nitrogen should be applied before the crop is 30 inches tall. When sweet sorghum is grown immediately behind a legume crop, the nitrogen application rate can be reduced or eliminated without harming yields. Otherwise, a nitrogen rate of 40 pounds per acre is recommended. Avoid planting sorghum in fields where poultry litter has recently been applied, because soil nitrogen will be excessive.

The basic fertilization for a well-drained silt loam soil with a medium fertility soil-test level is a standard fertilizer with a 1:1:1 ratio to supply approximately 40 pounds each of nitrogen (N), phosphate (P₂O₅), and potash (K₂O) per acre. Rates of these nutrients should not be over 50 pounds per acre on low fertility soils, and only nitrogen (not over 40 pounds per acre) is required on high-fertility soils.

**Date Of Planting**

Tests have shown that seedling growth of very early-planted sweet sorghum is slow, making weed control more difficult. With very late planting, the total production is often low. Research at Merid-
ian, Mississippi, suggests that the optimum planting period at that location is from mid-April to mid-May. These dates are also preferred for planting in Central and South Alabama. May plantings may be more desirable in North Alabama.

**Plant Spacing**

Sweet sorghum is commonly grown in rows spaced 36 to 42 inches apart. Spacings wider than 42 inches can result in some yield reduction.

Planting sweet sorghum in hills of two or more plants has been common in the past. Drill planting with plants spaced 8 inches apart in the row has resulted in comparable stalk and syrup yields. Hill plantings may give better emergence in crusted soils.

Planting depths for sweet sorghum seed should be about 1 inch, with deeper coverage on light sandy soils and shallower coverage on heavy clay soils.

**Weed Control**

Cultivation is widely used for weed control in sweet sorghum. Two or three cultivations may be needed for good weed control in some fields. No herbicides are labeled for use in sweet sorghum. Perennial grasses such as Johnsongrass and Bermudagrass are not easily controlled in sweet sorghum. Fields badly infested with these weeds should be planted with some other crop.

**Diseases**

Sweet sorghum is susceptible to a number of diseases including anthracnose (red stalk rot), fusarium, and maize dwarf mosaic. Since no fungicides are labeled for sweet sorghum, these diseases must be controlled by using resistant varieties and by crop rotation. Most older varieties are now so susceptible to these diseases that they should not be planted for syrup production.

**Harvesting**

The highest-quality syrup is produced when the sorghum is harvested before the mature or ripe seed stage. Sucrose percentage and syrup yields generally increase as the stalk matures to the ripe seed stage.

To obtain high-quality syrup and high yields, most varieties should be harvested when the seed is in the soft dough stage. Dale makes a higher-quality syrup when harvested just prior to the hard dough stage.

Sweet sorghum for syrup production can be harvested by hand using a knife or hoe when acreage is small. Machine harvesting with a binder is sometimes used on larger acreages. Producers with large acreages should consider using a harvest system that chops the stalks into 6- to 8-inch sections.

The seedhead and peduncle (between the base of the seedhead and the top node) should be removed before processing the stalks. Seedheads may be dried and threshed so the seeds can be used for the next year’s crop. A germination test should be made before planting these seeds.

Excellent-quality syrup can be made without removing (stripping) the leaves. However, the stalks should not be crushed while the leaves are still wet. Delay milling for 3 to 5 days. This delay will allow the leaves to dry out, the stalks to lose some water, and natural enzymes within the stalk to invert some of the sucrose. These changes will make the syrup easier to cook and less likely to crystallize.

**Processing The Syrup**

**Juice Extraction**

All the mills in operation today are old—many with patents dating before 1900. Replacement parts must often be specially fabricated or cannibalized from other mills. Mills of the types currently used are scarce; consequently, mill repair and replacement continues to be a major concern.

The percentage of juice extracted is an important factor in mill operation. The juice extraction rate depends upon the mill speed, the moisture content of the cane, the mill adjustment, and the feeding rate.

The rollers must be adjusted to spacings close enough to produce maximum extraction. To set the mill rollers initially, evenly space the feed roller ⅜ inch from the top roller. As a general rule, juice is lost if the bagasse (“pomace” or “chews”) con-
tains visible juice and is not broken at the joints as it comes from the mill.

Cane ordinarily contains more than 70 percent water and 10 to 15 percent fiber, but it is impossible to extract all the juice. With a three-roller power mill, the weight of the juice extracted should be 50 to 60 percent of the weight of the stalks, unless they are very hard and dry.

In smaller mills, and with sorghum cane of poor quality, the extraction is frequently 50 percent or lower. Moreover, early in the harvesting season, when the crop may be less mature, the juice may be low in soluble sugars. In such cases, the yield of juice is proportionately reduced.

When unusually low extraction is being obtained in a small mill, it may be practical to gather up the bagasse and run it through the mill again. Often 50 percent more juice can be obtained by “double passing” than by putting the stalks through only once.

Be sure to check the mill to see how much juice it is extracting. Under normal conditions, an efficient mill will deliver 50 to 55 pounds of juice from 100 pounds of clean stalks. Weigh 100 pounds of stalks, run them through the mill, and catch and weigh the juice. If necessary, tighten the rollers to increase the extraction of juice. A mill should be able to apply from 50 to 100 tons of pressure on the stalks.

As a general rule, juice is lost if the crushed stalks contain visible juice and are not broken at the joints as they come from the mill. Many older mills cannot be adjusted tightly enough without breaking to reach this maximum amount of extraction. When adjusting, always tighten the rollers down slowly.

**Manufacturing The Syrup**

The building where the juice is evaporated to syrup should be a sanitary area suitable for food preparation, meeting good manufacturing practices (GMPs). The area should be covered and screened to keep out filth, pets, birds, rodents, and insects. The floor should be concrete or made of other impervious material that is easily cleaned. It should be graded to drain so it can be washed with water.

A pressurized, potable water source for cleaning and hand washing should be available. Hand washing facilities complete with soap, hot water, and single service towels must be available in the processing area. A sanitary toilet should be conveniently located. For specific state regulations on the requirements for the processing building and area, contact your local Health Department.

**Filtering And Settling The Juice**

Raw green juice, when squeezed from the cane, should be filtered through a coarse screen to filter out the larger pieces of dirt, cane, and debris. The large gears on a horizontal mill may be positioned directly over the expressed juice flowing out of the press.

Care should be taken to ensure that grease from the gears does not contaminate the raw juice. This problem can be corrected by placing a strip of sheet metal below the gears to deflect any excess grease. Use only food-grade grease. This lubricant can be obtained from a lubricant/fuel supplier.

The juice should be run from the mill through a pipe or hose to the juice-settling tanks, where it is strained through a fine mesh screen muslin or fine nylon cloth as it enters the tank. Use two or three tanks, each big enough to hold the juice from 2 to 3 hours of milling.

Let the juice settle a minimum of 2 hours before evaporating. Holding the juice more than 3 to 4 hours without refrigeration or without heating (as described later) may cause it to ferment and spoil. The outlet on the settling tank should be at least 1 inch above the bottom of the tank so the settled material is not drawn into the evaporator. A separate opening in the bottom of the tank will be needed to clean out the tank after drainoff. In some operations, settling tanks are heated to a point just below boiling and held for about 2 hours. The temperature should not be allowed to go below 160°F as it is held overnight. This holding temperature allows for much of the skimings to rise to the top and the settlings to precipitate to the bottom.

The design of the tank is important, since heat applied directly to the bottom of the tank causes
problems in settling. Using this preheat system with a steam-heated operation is ideal. The steam coils are placed on the side of the preheat tank instead of the bottom. Removal of skimmings and settlings in the preheat tank allows contaminates to be removed early in the process and reduces the chances of “boiling-in” excess skimmings during the evaporation step.

The earlier you remove the skimmings and insolubles from the juice, the better chance you have of making high-quality, light-colored syrup. Once skimmings are boiled into the syrup, they are almost impossible to remove later in the process.

**Evaporating The Juice**

Evaporators may be batch (kettles) or continuous-flow types. The 12-foot continuous-flow evaporator is the most common. Designs, blueprints, and information for constructing the evaporator and furnace are available from county Extension offices. A detailed description of several furnaces and evaporator systems in Tennessee is available from the Tennessee Cooperative Extension Service.

Most pans are the continuous type with dimensions about 3.5 feet by 12 feet by 6 inches, but their size can vary considerably. They are divided into many sections by baffles that extend across the pan and are arranged so the open end of one is opposite the closed ends of those on either side of it. A self-skimming trough may be attached to each side of the evaporator, which greatly reduces the labor for skimming the juice. A “water jacket” in the final 6-inch section of the evaporator pan helps moderate the temperature of the finished syrup and helps keep the syrup from scorching.

Juice evaporators are made of galvanized iron, black iron, stainless steel, or copper. Use of galvanized iron is highly discouraged when making syrup today. Because cane juice is slightly acidic, it leaches the zinc out of the galvanized metal. These pans are usually made with lead solder, as well. This lead also leaches into the syrup. These pans should not be used today.

Black iron pans will make the syrup darker, because high iron levels leach into the syrup. The use of iron is discouraged, although there are no known health hazards at this point.

The ideal metal for evaporators is stainless steel or copper. Both metals transfer heat efficiently. However, stainless steel evaporators need a much more uniform heat source for even heat distribution. Most new pans today are made of stainless steel. Most processors are using stainless steel for all containers in the process. The ideal source of heat is steam, although most producers use LP gas.

The quality of the syrup depends to a large extent upon the variety of sweet sorghum, the type of soil on which the crop is grown, the type and amounts of fertilizer used, and the kind of growing season. However, it may also be greatly influenced by the equipment and process used in manufacturing and by the skill of the syrup maker.

**Skimming.** When heat is applied to the juice, much of the starch becomes soluble, but certain proteins and other nonsugar substances begin to coagulate. If allowed to settle, some of this coagulated material rises to the surface of the juice and some sinks to the bottom. The best practice is to remove this material as quickly as possible by skimming as soon as it appears on the surface of the juice.

Success in making syrup depends first on the thoroughness with which the juice is skimmed before it begins to boil rapidly. The agitation of the juice due to active boiling breaks the coagulated material into smaller particles, making them more difficult to remove by skimming than the original mass. This breaking up of coagulated material is commonly referred to by syrup makers as “boiling-in” the impurities.

Additional nonsugar substances separate as boiling continues and the juice becomes denser, making it advisable to continue the skimming until the juice has been evaporated to the density of finished syrup, even though careful skimming has been done at the beginning of the evaporation.

**Continuous evaporators** have many points of superiority. They are constructed in such a way as to produce a quick concentration of the juice to syrup, and, with proper operation, to facilitate efficient skimming. If the pan is operated so
the skimmings are properly concentrated and removed, the major function of the operation is to ensure that the syrup is drawn from the pan when the proper density is reached.

The advantages of continuous-type evaporators are:

- The design allows for rapid evaporation, which is essential in making light-colored syrup.
- The syrup is concentrated in a thin layer, thus increasing the rate of boiling and foaming and affording a better opportunity for thorough skimming.
- Heat is applied to the bottom of the evaporator, giving an upward motion to the coagulated material, which makes skimming easier.

The disadvantages are:

- More attention is required to maintain a properly regulated flow of juice.
- There is increased danger of scorching the syrup and altering its color and flavor.
- More careful attention to firing is necessary.
- It requires more skill to obtain uniform syrup density.

In continuous evaporation, a steady stream of juice flows by gravity into the front end of the pan and then flows slowly to the opposite end, at which point it reaches the density of syrup. The juice end of the pan is sufficiently lower than the finishing end, to maintain a juice layer from 2 to 2½ inches deep. This depth should give a layer ½ to 1½ inches deep (preferably only ¾ to 1 inch) in the finishing end of the evaporator.

In other words, the juice end of the evaporator is mounted on the furnace about 1 inch lower than the syrup end. The evaporator must be level from side to side.

If operating during the day only, the evaporator should be kept partly full of water overnight. This can be accomplished by flooding the pan with water after drawing off as much syrup or semisyrup as possible. At the end of the day, the evaporation need have reached only the semisyrup stage. If the semisyrup is well skimmed before removal, in the morning it may be put back into the syrup end of the evaporator. The syrup compartment is shut off from the rest of the pan by means of a gate until the evaporator is working well again with fresh juice.

The easiest way to begin the day’s operation is to start with juice in the pan over only two-thirds of its length, with either water or semisyrup in the syrup compartment, blocked off with a gate. Transferring juice or syrup of low density to parts of the pan where the syrup is becoming too dense is bad practice, but it is sometimes unavoidable at the start.

As soon as syrup is being finished in the back compartment of the evaporator and clean semisyrup is being made from the fresh juice, it is time to permit a continuous flow of juice. The flow of juice ordinarily should be kept as nearly constant as possible without dipping from one compartment to another. Such dipping detracts from the clarity of the syrup, because of the mixing of juice and syrup at different stages of clarification. Mixing of high- and low-density juice usually causes a persistent cloudiness in the finished product. The rate at which juice is run into the evaporator and syrup is run out is now controlled by the syrup maker.

When the evaporator has started to work well, the juice seldom boils in the first compartment, which is the coolest part of the evaporator, unless for some reason the inflow of cold juice is temporarily stopped. This juice has a smooth, relatively cool surface, over which the skimmings form a blanket. This blanket is occasionally removed with a perforated skimmer.

If the furnace is properly constructed, the boiling of the juice increases in vigor toward the back end of the pan as far as the section under which the fire is hottest. This causes the skimmings to run counter to the flow of juice to the cooler or front portion of the evaporator.

By the time the juice reaches the hottest part of the pan, which is about 1½ feet beyond the middle, it has been evaporated nearly to semisyrup density and is fairly well cleaned. As the syrup becomes more concentrated, however, additional impurities separate out, and this material also should be carefully removed by skimming. For efficient skimming, a hot fire must be maintained to “roll” the foam.
Concentrating The Syrup

A common problem with continuous evaporators is the difficulty of concentrating the syrup to uniform density. Many operators are able, by experience, to judge fairly accurately the density of syrup while it is still boiling. Some do this by dipping a skimmer or a syrup “rake” into the boiling syrup, holding it up, and noting how the cooling syrup “flakes off.” But even an experienced operator is not always consistent with this subjective method.

No amount of experience can take the place of accurate measuring, and the uncertainties of guessing the density can be easily eliminated with the use of a syrup-maker’s thermometer. Syrup from different varieties of sorghum boils differently. A good thermometer is more useful in the operation of a shallow evaporator than is the hydrometer, which is often recommended for this purpose.

In using the hydrometer, it is necessary to draw off a cylinder of syrup from the evaporator and float the hydrometer in it. This procedure is troublesome when using a shallow evaporator, because the syrup is very hot and is in such a thin layer that it is not easily dipped out.

The thermometer most suitable for the purpose is one protected by a substantial metal case, with a 10-inch scale graduated from approximately 50° to 250°F. The bulb should not touch either the bottom or side of the evaporator. By providing a broad metal backpiece so that it will stand up, such a thermometer may be kept continuously in the syrup to indicate accurately the point of final evaporation.

When you use a thermometer to test a syrup for its density, occasionally check the accuracy of the thermometer by placing it in boiling water and noting the boiling point. Water should boil at 212°F at sea level, and for every 500 feet above sea level the boiling point is lowered approximately 1°F.

Finishing The Syrup

The syrup is usually finished at a temperature 14° to 15° higher than the boiling point of water if a syrup of fairly heavy density is desired, although a slightly different finishing temperature may be used with equal success. Therefore, when using an accurate thermometer at a point 500 feet above sea level, finished syrup would boil at 225° to 226°F, and at 1,000 feet above sea level it would boil at 224° to 225°F.

A syrup with 78-percent solids can be produced by concentration until the boiling point of the syrup is 226°F. This relationship permits the density of the syrup to be readily determined by simply observing the syrup temperature during boiling.

To enable the juice to evaporate uniformly from the pan, the temperature must be controlled along the pan’s length. Boiling of the juice should start about one quarter of the length of the pan from the juice end and remain at a constant temperature until the skimmings are completely removed before reaching the last quarter of the pan. As the syrup density increases, the boiling temperature will gradually increase.

When shutting the pan down, allow the furnace to cool slightly before the syrup is drained off. Remember that no part of the pan should be dry for more than an instant or the syrup’s quality may be impaired, and the pan can be damaged. The semisyrup in the center of the pan must be allowed to follow closely behind the syrup being moved to the outlet.

Strain the finished syrup through muslin, two thicknesses of cheesecloth, or 45-mesh screen wire as it is run into a suitable container for cooling.

Cool the strained syrup obtained from each “stir-off” in a large container to about 140° to 160°F as quickly as possible before putting it in a permanent container of 1 gallon or smaller. The faster you cool the syrup, the less color will develop.

Some producers pump the finished syrup through a pipeline that passes through an enclosed cool-water tank to lower the temperature quickly to 140° to 160°F. The syrup is then strained into holding containers for canning. This quick cooling helps maintain the syrup’s lighter color, compared to slower cooling methods.

If the enzyme isomerase is added to help prevent crystallization, the syrup must be below
150 °F. Otherwise the enzyme will be inactivated.

The finished syrup is thoroughly sterilized by boiling. If canned above 150 °F in clean containers, it will not spoil or ferment. The container must be airtight to prevent fermentation or surface mold growth. Thoroughly wash large containers such as metal drums several times with boiling water or steam and dry them thoroughly before adding syrup. It takes from 6 to 12 gallons of raw juice to finish 1 gallon of sorghum syrup. The finished syrup will weigh approximately 11.5 pounds per gallon.

Semisyup

Since juice cannot be held for long periods of time without spoiling, making semisyup is an attractive alternative in some cases. Research at the University of Tennessee has shown a semisyup of at least 45 °Brix can be held at 68 °F for at least 21 days. A reading in degrees Brix indicates the percentage by weight of sugar in a solution at a specified temperature. Higher concentrations can also be made and the storage time would be lengthened, if stored at the same temperature.

How long you can safely hold semisyup depends on the sugar concentration, the temperature at which it is held, and the sanitation of the system. Also, if you install a finishing pan in your process to concentrate the semisyup to finished syrup, the process for obtaining your desired Brix will be more accurate.

Care Of The Evaporator

It is seldom desirable to make syrup day and night; therefore, after each day’s run the evaporator must be cleaned. To do so, run water into the pan in the late afternoon and let it follow the syrup as it is finished and drawn off. Leave at least 1 inch of water in the pan overnight. Never heat a dry pan, or it will warp.

In the morning, scrub out the pans with a non-metallic abrasive cleaner. A 1- to 2-percent nitric acid solution should also be used on the stainless steel pans following the first cleaning. Nitric acid is preferred over sulfuric acid for cleaning stainless steel pans. The alkaline detergents (used the night before) will remove the mineral deposits, and

the acid solution (used the next morning) will completely remove salt precipitates from the stainless steel pan. Always wear rubber gloves when using any of these cleaners.

The used solution should be discharged to a covered pit away from trees or streams to prevent injury and pollution. Thoroughly flush out the evaporator with clean water before beginning to cook. Rubber gloves and safety glasses or goggles should be worn when using these cleaning materials.

General Sanitation

Sorghum, like any other food product, should be processed under good sanitary conditions. Everyone in the exposed product area must always wear clean clothing and hair restraints. Use good manufacturing practices during all processing operations and in the construction of the facility.

Even though bacteria will not generally grow in sorghum syrup, because of its high sugar concentration, yeast and molds will grow in it. Small areas of residual syrup, especially if diluted with water, harbor millions of yeast and mold cells and will increase the chance of syrup spoilage.

All surfaces coming into contact with the juice or finished syrup should be washed, sanitized with \( \frac{1}{2} \) cup sodium hypochlorite (Clorox) per gallon of water and allowed to air dry. Fill jars with hot syrup and seal them immediately. This will prevent spoilage. Use food grade products, including the grease used on the mill, for all operations.

Labeling Your Containers

Each container must be labeled with a true statement identifying the product; i.e., sorghum syrup, sorghum and corn syrups, or corn syrup with sorghum syrup. Any optional ingredients or “processing aids” used in the processing of the syrup, such as enzymes, do not have to be labeled. The name and address of the manufacturer or distributor and the contents of the package (volume or net weight) must also be on the label.
Using Enzymes For Processing Syrup

Gelling

Depending on the growing season and the variety of sweet sorghum grown, sorghum syrup will occasionally gel when cooked to the required sugar concentration. Gelling results from higher-than-normal amounts of starch in the raw juice. It is usually associated with over-mature sorghum (as cane matures the sugar converts to starch).

When made from sorghum harvested at the proper stage and allowed to settle over 2 hours, most sorghum juice will not contain excessive starch. Occasionally, however, gelling will take place even when the juice is allowed to settle properly.

Managing starch in the juice is one of the most difficult problems in producing consistently high-quality syrup. When the juice is boiled, the starch thickens, as gravies and cream pies thicken, causing the syrup to "gel."

Enzymes

If settling the juice does not remove enough of the starch to prevent gelling, an enzyme that breaks down starch into sugars and dextrins can be used. Several methods can be used successfully if you have a basic understanding of starch and enzymes.

Starch occurs as granules, which are protected from enzyme action because they are insoluble in cold juice. Therefore, starch granules must be ruptured before the enzymes can act on them. Depending on what type they are, the starch granules will rupture when heated to a temperature between 140 °F and 180 °F. The exact temperature at which the starch granules in sweet sorghum will rupture is unknown. So, the juice should be heated to more than 180 °F.

All enzymes are proteins and are destroyed by heat, but some are more heat-stable than others. Of the three types of amylase enzymes (enzymes that will convert starch into sugar or dextrins), two are relatively heat-stable, while the other is easily destroyed by high temperatures. Although any of the enzymes can be used, the heat-stable enzymes are safer since they are less likely to be accidentally destroyed by heat.

Enzymes initiate reactions but are not consumed in them, so only small amounts of the enzyme are necessary. The amount of enzyme needed depends on that particular enzyme's activity, but the recommendations should work for most of the commercial, high-temperature enzymes available. Detailed instructions are available from the enzyme supplier.

Methods To Prevent Gelling

One method to remove starch is to heat the juice, cool it down, and then add the enzyme. First, heat the raw juice to about 210 °F for a few minutes to rupture the starch granules. After heating, allow the juice to cool to 185 °F or below and then add about 30 ml (2 tablespoons) of the amylase enzyme (liquid) per 100 gallons of juice. Mix the enzyme thoroughly with the juice, either by hand stirring with a paddle or by mechanical agitation, and allow it to settle for an hour or more so that the enzyme will have time to convert the starch to sugar. Then evaporate the juice in the usual manner.

Another way to remove the starch is to add 30 ml (2 tablespoons) of a high-temperature amylase enzyme (liquid) to 100 gallons of the raw juice and slowly heat the juice during evaporation. The juice should be heated slowly enough so the starch granules rupture and allow the enzymes to convert the starch to sugar before the heat destroys the enzyme. The juice is then evaporated as usual.

A third method, and one of the best, for removing the starch is:

- Evaporate the juice to a semisyrup.
- Draw the semisyrup off into large containers and let it cool to 185 °F.
- Add a high-temperature enzyme (liquid) to the semisyrup. Add the enzyme at the rate of 30 ml (2 tablespoons) of enzyme to the semisyrup produced from 100 gallons of raw juice.
- Let it stand for one or more hours to convert the starch into sugar.
- Finish the semisyrup in the usual manner.
Occasionally, finished syrup will gel even though the juice was allowed to settle thoroughly. In this case, the finished syrup can be reheated to 160 ° to 180 °F and treated with 30 ml of the enzyme per 100 gallons of the finished syrup and then rebottled. Although reboiling the syrup to destroy the enzyme may be desirable, it is not necessary since the enzyme acts only on the starch in the syrup. This reheating will normally make the syrup darker in color.

Crystallization

Sorghum syrup will often crystallize during storage. Crystallization is frequently a problem for producers who store their syrup through the winter months. Crystallization is usually caused when the sugar sucrose is present in concentrations too great to remain dissolved at the storage temperature. You can reduce crystallization by converting some of the sucrose to glucose and fructose (other forms of sugar) with the enzyme invertase. Glucose will also crystallize readily under certain conditions (honey is a good example).

Methods For Using Invertase

Invertase is an enzyme that will be destroyed if it is heated above 150 °F. However, it can be added at several points in the process.

For processors who make a semisyrup and hold it in a tank for further evaporation, this holding tank is one point in the process where the enzyme may be added. As long as the semisyrup remains below 150 °F, the enzyme will continue to break sucrose down into its two monosaccharides (glucose and fructose). Adding the enzyme in the semisyrup tank allows the processor to experiment with how long to allow the enzyme to work to best prevent crystallization. When the semisyrup is evaporated to the final syrup, the enzyme will be inactivated.

Another recommended method is to finish off the syrup in the usual manner and cool it below 150 °F. Then add 1 pound of invertase per 100 gallons of finished syrup and bottle. One of the problems with this technique is that eventually all the sucrose will be broken down to glucose and fructose. This breakdown does not change the taste or sweetness of the syrup, but, chemically, the syrup will look similar to corn syrup. On several occasions, the FDA has suspected invertase-treated syrup of being adulterated with corn syrup. Every case, however, was resolved favorably for the producer.

A Note About Enzymes

Enzymes are not stable over long periods of time. Depending on the source of the enzyme, liquid enzymes should be stable for 6 months or more and dry enzymes for about 12 months or more. Some suppliers have analyzed enzymes after 4 years of storage at refrigeration temperatures and found them to retain 75 percent of their original activity. However, you should not buy a large supply of enzyme at one time, expecting to use it for several years. Store all enzymes in the refrigerator.