Invertase method

NOTE: This circular takes the place of the one on the subject sent out previously.

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HOW TO PREVENT SUGARING OF SUGARCANE SIRUP.*

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Variety of Cane: Some varieties of sugarcane yield sirup that almost always sugars; other varieties give sirup that seldom, if ever, shows crystallization. For example, sirup made from Cayana cane is less likely to sugar excessively than is sirup from some of the P.O.J. and other newer varieties. The fact that sirup from some particular variety of cane almost always sugars excessively is due to the relatively high content of cane sugar in the juice of this variety. In addition to its cane sugar content, all sugarcane contains invert sugar, and in sirup that does not crystallize the proportions of cane sugar and invert sugar may be said to be well balanced.

Maturity of the Cane: As is well known, cane that is quite mature is most likely to yield a sirup that sugars. From the standpoint of flavor, however, better quality sirup can be made when the cane is more mature, and it is considered poor practice to grind green, or immature, cane for sirup simply to avoid the danger of sugaring. Likewise, the practice of topping the cane high for the purpose of preventing crystallization is inadvisable. Do not expect to make as good a sirup from unripe cane and from cane tops as you can make from more mature cane, properly topped and stripped. It is none too easy to make the best quality sirup from cane of good quality, so why give yourself purposely the handicap of working with poor material?

Density of the Sirup: The degree of sugaring depends greatly upon the density of the sirup, more crystallization, of course, being experienced with thicker sirups. Stirring the finished sirup while it is cooling, or afterwards, causes sugaring to take place more rapidly. Although the standard commercial density is 38.5° to 39° Baumé, it is believed that the sirup density preferred by most consumers is 40° Baumé, measured at ordinary temperature. With some varieties of cane a very objectionable degree of sugaring often occurs in 40° Baumé sirup.

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*(NOTE: The invertase process described on page 2 may also be used for sorghum sirup to prevent cane sugar crystallization, but use only 1/2 as much invertase. Read the circular on "How to Prevent Slow Boiling, Scorching, Clabbering, and Sugaring of Sorghum Sirup" first if you are making sorghum sirup.)

Various Methods for Preventing Excessive Sugaring: Fortunately, there are several methods for preventing crystallization. One of these methods, which is sometimes practiced commercially, consists in purposely allowing a certain proportion of the juice to sour, and then adding this sour juice to the fresh juice in specified amount. The sour juice contains acid which converts a portion of the easily crystallizable cane sugar into invert sugar. The resulting sugar content of the sirup is hence more properly balanced and holds up without depositing cane sugar crystals. However, the quality of sirup made by the sour juice process is considered somewhat inferior from the standpoint of flavor. This method is also extravagant of juice, as so much juice must first be soured and reduced in sugar content before it is added to the fresh juice. A very serious objection is the frequent occurrence of a "ropy" or "slimy" fermentation in juice held for souring. The addition of very much "ropy" juice will ruin the rest of the juice for the production of good quality sirup.

Another method consists in converting some of the cane sugar into invert sugar by means of a commercial acid. The use of acids, however, is considered to give sirup of inferior quality - somewhat similar in flavor to that of sirup made from unripe cane or from cane tops.

The procedure of grinding more than one variety of cane is considered logical, and is sometimes practicable. A variety that is known to contain less crystallizable sugar can be mixed with one that yields sirup of more pronounced sugaring properties. The juices may be mixed by grinding two varieties of cane instead of only one, or the sirup produced from two different cane varieties may be mixed to give a product containing more nearly the ideal proportions of cane sugar and invert sugar.

Crystallization may also be prevented by mixing the sirup with commercial glucose, or corn sirup, but this procedure can not be used for a product which is to be sold as pure sugarcane sirup. Moreover, in seasons when sugarcane sirup is plentiful, the cost of corn sirup in small quantities is likely to be so high that there would be little or no profit on the additional gallons of sirup produced by using the corn sirup. The small-scale sirup maker would thus have an additional quantity of sirup to market with difficulty at a time when prices were low.

The Invertase Process

The method that is recommended to meet the requirements of most makers of sugarcane sirup for preventing crystallization effectively, while at the same time giving an excellent quality of sirup, is the invertase process. The use of invertase, which is a clear, water extract of yeast, and not a chemical in the ordinary meaning of this term, converts a part of the cane sugar into invert sugar, which is just as sweet and wholesome as cane sugar but sugars or crystallizes much less readily.

The recent development of a process for using vegetable decolorizing carbons (see mimeographed circular, "Suggestions on Making Best Quality Sugarcane Sirup, and How to Use Decolorizing Carbon") in farm-scale sirup

production now makes it possible to accomplish two improvements at one and the same time. Practically the same method of operation and the same equipment that is used in producing sirup of improved and more uniform color and flavor, by the use of decolorizing carbon, can be employed in carrying out the invertase process to prevent excessive sugaring.*

In brief, the invertase process is carried out as follows: The juice from the mill (with or without the addition of decolorizing carbon) is carefully skimmed and evaporated as usual in an evaporator, or kettle, or batch pan. The evaporation, however, during one day's operation is only to the semi-sirup stage, which amounts to about 2/3 of the total evaporation. When it tests 20° Baumé, while still very hot, the semi-sirup is collected for invertase treatment in a tank large enough to hold the entire day's output. This is the same tank in which carbon-treated semi-sirup is received, if you are also using the decolorizing carbon process. The invertase is permitted to act on the semi-sirup while the carbon and sirup sediments are settling out. Moreover, it is a very good plan to arrange to settle the semi-sirup in order to remove the sirup sediment, regardless of whether or not the use of carbon and/or invertase is being practiced.

The required amount of invertase is now added to the semi-sirup. As invertase is destroyed at fairly high temperatures, the semi-sirup must first be at a suitable temperature; it should be allowed to cool to 140° to 145° Fahrenheit. Semi-sirup which tests 20° Baumé when practically at a boiling temperature will test 22° to 23° Baumé at 140° to 145° Fahrenheit. The quantity of invertase required depends on the volume of semi-sirup. As invertase is used in relatively small quantities, for accuracy of measurement the required quantity should be measured in terms of a small unit of volume, such as the cubic centimeter. The proportion required varies ordinarily from 40 to 60 cubic centimeters of invertase for every 100 gallons of semi-sirup. Small bottles, glass vials, or cylinders graduated in cubic centimeters, usually sold in drug stores, are recommended for measuring the invertase accurately. It is mixed with a little water (about a quart) and then added to the tank of semi-sirup. Because of the small proportion of invertase added, the sirup must be well stirred so as to thoroughly mix it with the invertase. Be sure to cover the tank or barrel, after adding the invertase, so that the semi-sirup will remain as warm as possible.

Although about 50 cubic centimeters of invertase per 100 gallons of semi-sirup is usually required, it may be necessary to vary the quantity somewhat in certain cases, owing to differences in the proportion of cane sugar and invert sugar originally present in the juice, the proportion of cane sugar converted into invert sugar during evaporation, and the strength of the invertase. The best way to determine for the first time whether too little or too much invertase has been added is to observe the color and flavor of the sirup and its tendency to crystallize after evaporation to final density. If the sirup does not differ appreciably in quality

*Note: The use of decolorizing carbon in farm-scale methods for making sorghum sirup is not recommended.

from sirup obtained from the same kind of cane when no invertase was used, and if no sugar separates from the sirup, it is safe to conclude that the proper quantity of invertase has been added. If, however, the color and flavor of the finished sirup differ appreciably from those of sirup of the same density made without invertase, slightly less invertase should be used thereafter. Conversely, if the finished sirup shows a tendency to deposit sugar, the proportion of invertase used for the next lot should be increased.

The tendency of sirup to crystallize may be easily and quickly tested by permitting a small sample (about a quart) to cool until it is lukewarm and then adding about a teaspoonful of fine granulated sugar and stirring occasionally over a period of two or three hours. If no sugar in excess of that which has been added appears in the sirup after it has stood over night, the quantity of sugar which is likely to be deposited later will be very small, at the most. The smallest proportion of invertase which will prevent crystallization should, of course, be used, and once this has been determined approximately, the same amount may be used regularly for the rest of the season.

Since invertase does not act instantaneously, a certain period is required for it to convert the necessary quantity of cane sugar into invert sugar. It has been found convenient to allow approximately 12 hours (over night) from the time the invertase is added to the semi-sirup until evaporation to final sirup is started. The invertase is usually added when quitting work at night, and final evaporation of the semi-sirup is begun when operation is resumed next morning.

For continuous operation, two holding and treating tanks or barrels are required. Each of these should be of sufficient capacity to hold a day's run of semi-sirup. Well constructed cypress tanks, of planed lumber, and provided with covers hold the heat very well. Barrels with covers are satisfactory for small-scale operations. Tanks made of wood and lined with thin copper make especially good containers. These barrels or tanks should, of course, be carefully washed each day to prevent fermentation.

If you are using a continuous evaporator, it is advisable to install a small batch pan for evaporating the treated semi-sirup to finished sirup density. This small additional expense is well justified, considering the improved quality of sirup obtained and the increased boiling capacity. For example, while grinding cane the next morning, the semi-sirup treated the previous day can first be boiled down in the smaller finishing-off pan before you are entirely ready to start boiling on the larger evaporator. Or the two pans may be operated at the same time, provided the supply of juice is ample, and a second holding tank for semi-sirup is provided for continuous operation.

In boiling the semi-sirup to finished sirup density, it is advisable to evaporate as rapidly as possible to avoid altering the flavor of the sirup. Start with a small fire and keep the thin semi-sirup stirred until it gets hot; then evaporate rapidly. It is best to work with rather small batches.

For a 12-foot evaporator, a small batch pan 5 feet long x 2-1/2 feet wide x 8 or 10 inches deep should be of sufficient capacity. This pan can be home-made, with cypress sides and galvanized iron or copper bottom, or it can easily be made entirely of metal by a local tinsmith. The cost is very small, considering its value. Such a pan should be provided with its own furnace. It is well to make the pan with a center partition and gate.

Those who use kettles or batch pans for sirup making can, of course, use these for evaporating semi-sirup to finished sirup density. And sirup makers who are using continuous evaporators can, with certain changes in the evaporator and method of operating it, make semi-sirup and finished sirup on the same evaporator at the same time. As previously stated, however, a separate batch pan is very convenient to supplement a continuous evaporator, and makes possible an increased daily production of sirup, owing to the increased boiling capacity. It is also easier to handle a separate batch pan than to make both semi-sirup and finished sirup on the same evaporator.

By using the invertase process on semi-sirup, as described above, the cost for invertase is only one-half a cent to one cent per gallon of final sirup. Those who have serious trouble with sugaring will find this process very much worth while. Proper canning is depended upon to prevent fermentation of 39° to 40° Baumé sirup.

Invertase may be obtained from the following firms:

Difco Laboratories, Inc., Detroit, Mich.
Haug & Co., 370 Seventh Ave., New York, N. Y.
Nulomoline Company, 111 Wall Street, New York, N. Y.

The strength of the invertase preparations supplied under different trade names by these concerns varies sometimes by as much as 25 percent and the price may vary accordingly. The proportion to be used in sirup making, however, usually lies between 40 and 60 cubic centimeters per 100 gallons of semi-sirup, as given in the above directions. It is best to specify in ordering that invertase of standard strength is wanted for sirup making. One pound of standard strength invertase contains 380 cubic centimeters, and one gallon weighs 10 pounds.

Sirup makers' thermometers and Baumé hydrometers may be obtained from the firms listed below. In ordering sirup makers' thermometers and Baumé hydrometers, it is best to specify that they are to be used in making sugar cane sirup.

Eimer and Amend, 3d Ave., 18th to 19th Sts., New York, N.Y.
Taylor Instrument Companies, Rochester, N. Y.
Thomas Company, Arthur H., West Washington Square, Philadelphia, Pa.
Will Corporation, Rochester, N. Y.

In giving the above names of firms supplying invertase and sirup makers' thermometers and Baumé hydrometers, no guaranty is expressed or implied,

nor is it to be understood that the products of these concerns are recommended over those of others which may be engaged in the same business of which we have no record. The names are furnished for your convenience and not by way of specific recommendation.

Other Publications on Sugar-Cane Sirup.

U. S. Department of Agriculture, Department Bulletin 1370, "Sugar-Cane Sirup Manufacture."

U. S. Department of Agriculture, Bureau of Chemistry and Soils, Mimeographed Circular entitled "Suggestions on Making Best Quality Sugar-Cane Sirup, and How to Use Decolorizing Carbon."

U. S. Department of Agriculture Circular 284, "Sugar-Cane for Sirup Production."