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Food Science and Technology Notes

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SOME NEWER IDEAS FOR USING CORN SWEETENERS IN ICE CREAM

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Although the subject of corn sweeteners has been discussed in these Production Tips on several occasions, there still seems to be some misunderstanding about the various corn sweetener products, their composition differences, and how they should be used in ice cream. This situation has caused confusion among ice cream manufacturers. I shall try to clear up the corn sweetener "problem" by re-defining the several products available and indicate how they should be used.

In the first place, corn sweeteners should not be called "corn sugar." Corn sugar, or dextrose, is a monosaccharide sugar obtained from the complete hydrolysis of corn starch. This sugar, which is about 75% as sweet as sucrose, has an approximate analysis of dextrose - 92% and water (as water of crystallization) - 8%. Since a 15% dextrose solution has a freezing point of 28.63°F compared with 30.16°F for a 15% sucrose solution, only 25% replacement of sucrose with dextrose is advisable. More than this amount of dextrose will cause difficulties with freezing, hardening, and storing of the ice cream because its freezing point will be too low. Dextrose (corn sugar) is not used much today in ice cream because it has no body building or heat shock resistance properties and because it lowers the freezing point too much.

The corn syrups used as sweeteners in ice cream include low D. E. (low conversion) syrup, regular corn syrup, high D. E. (high-conversion) syrup, and high maltose syrup. Intermediate corn syrups (48 to 57 D. E.) are available but are not used very widely in ice cream. In addition to the corn syrups there are dried syrups or corn syrup solids which are very useful as sweeteners in ice cream. More about them later.

Low D. E. corn syrups have a D. E. (Dextrose Equivalent) ranging from 28 to 37. They are characterized by having a higher proportion of the high molecular weight sugars in their composition. These polysaccharides provide excellent body

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building properties for ice cream and give it extremely good heat shock resistance. The replacement level for low D. E. syrups is up to 50% of the total sweetener, the amount used depending on the kind of frozen dessert and how it is to be distributed and sold. Ice milk, for instance, would usually require higher levels than high solids ice cream, particularly if it is to be distributed and sold through super markets. The big defect associated with the low-conversion syrups is their flavor "masking" property and "corn syrup" flavor.

Regular corn syrups have a D. E. in the range of 38 to 47 but it is usually 42-43 D. E. Regular corn syrup has been the most widely used type of corn sweetener for frozen desserts, but is being steadily replaced by the newer types of corn syrups. Regular corn syrup has more sweetening power and slightly less bodying effect than low D. E. syrup. Its sweetness is judged to be about 48 (compared with 100 for sucrose) at the concentration used in ice cream. The replacement level recommended is now up to about 30 to 35% of the total sweetener, and some companies have recommended as high as 45% replacement. The freezing point of ice cream containing regular corn syrup is not adversely affected since the substitution of regular corn syrup for sucrose actually tends to raise the freezing point. When regular corn syrup is used at replacement levels above 25%, it definitely yields a "corn syrup" flavor and has a flavor "masking" property which is undesirable.

The high-conversion syrups have a D. E. in the range of 58 to 68. These syrups are made by a dual conversion process in which acid conversion is followed by enzyme conversion. The dextrose-maltose ratio can be varied within certain desired limits by changing the type of enzyme used and by the extent of preliminary acid conversion. Advances in technology have resulted in two new types of syrup, the extra high-conversion syrup with a D. E. above 68, and high maltose syrup (to be discussed later). Dual conversion syrup has more sweetening effect since it is about 66% as sweet as sucrose at the concentration used in ice cream. The freezing point of a mix containing a small amount of high D. E. corn syrup is only slightly below that containing all-sucrose; however, at the high levels of substitution normally used (35 to 40%), the heat shock stability may be somewhat adversely affected by the slight freezing point depression. This type of syrup contains less of the polysaccharides in its composition and therefore it does not contribute as much to smooth texture, chewy body, and heat shock resistance of ice cream as do regular or low D. E. syrups.

In the past few years extensive interest has been focused on the high maltose type of corn syrup. These syrups are so named because of their relatively high content of the disaccharide maltose (note - sucrose is also a disaccharide). They contain from 36 to 52% maltose compared with 14.3% in regular corn syrup. This specially processed acid-enzyme converted syrup has a relatively low D. E. but in this type of syrup the D. E. is of no importance in evaluating the extent of conversion because maltose, which is proportionately high in relation to dextrose, is also a reducing sugar. Carbohydrate composition has now supplanted D. E., particularly in evaluating high maltose syrups. At the time the high maltose syrups were first introduced to the ice cream industry, there were claims made that these syrups had many superior properties. When used in the ice cream, these syrups reportedly resulted in smoother texture, freedom from gumminess, better heat shock resistance, and less freezing point depression in the mix. Many people recommended a sucrose replacement of 50% or more.

Six years ago we began a study at Rutgers to determine the effects of using high maltose syrups in ice cream. In one study we compared a high maltose syrup (36% maltose) with regular corn syrup. Among these ice creams containing corn

syrup, a 25% replacement with a high maltose syrup produced the highest flavor score (not significantly different than the control with no corn syrup). Increasing the level of sucrose substitution, up to 65%, with high maltose syrup, resulted in a distinct drop in flavor score. At the 50% replacement level the body and texture were unsurpassed. Generally, the improvement in body and texture in freshly made ice creams became more apparent after heat shocking and storage. In a comparative study the best all-around high maltose syrup of the three used was compared (at the 35% substitution level) with commercially available low and high D. E. syrups, and with regular syrup (at the 25% level). The high maltose ice cream was second only to the control (all-sucrose) in flavor, and second to the low D. E. product in body and texture. We concluded that this particular type of high maltose syrup, when used in ice cream formulations, produced an ice cream possessing more of the desirable organoleptic properties normally associated with the "ideal" product.

Our studies showed the best level of substitution to be 35%. Some suppliers of high maltose syrup recommend up to 50% of total sweetener depending on the frozen dessert characteristics considered most important by the manufacturer. Recently, I learned that one corn refining company is now recommending 60% replacement of total sweetener with high maltose syrup. I would advise caution, however, about using more than 35 or 40% unless carefully controlled tests indicate that total sweetener levels up to 50% or more will produce an acceptable product from the standpoint of flavor, body and texture, and heat shock stability.

Just a few words about dried corn syrups which are popular corn sweeteners for ice cream. They are made commercially by spray drying regular or low-conversion corn syrups and are available in the range of 28 to 42 D. E. The 36 and 42 D. E. corn syrup solids have been the most popular but the 28 D. E. has been found to be particularly useful in ice milk formulas and is becoming more popular. These dried corn syrup solids have the same composition, on a solids basis, as the syrup from which they are produced. They do not, however, have the same properties as the original syrup. They are more hygroscopic, that is, they have a decided tendency to absorb water. This property makes them act somewhat as a stabilizer when they are used in mix and this in turn improves the body and texture and increases the heat shock resistance of the ice cream. The freezing point of a mix containing corn syrup solids is actually slightly higher than an all-sucrose mix. The freezing point of a mix containing 16% sucrose is 26.99°F whereas a mix with 12% sucrose and 4% regular corn syrup solids has a freezing point of 27.18°F. The effect on the freezing point is even more marked as the D. E. of the corn syrup solids declines. The relative sweetness of 28 D. E. corn syrup solids is about 35% whereas the sweetness of 42 D. E. solids is about 60% as sweet as sucrose. This lack of sweetness, particularly of the 28 D. E. solids, is an advantage in such frozen desserts as ice milk and sherbet where 40 to 50% of the total sweetener may be corn syrup solids without excessive sweetness resulting. There are some disadvantages in using corn syrup solids. The solids are difficult to handle and require more labor compared with syrups. They must be weighed out instead of metered and they are hygroscopic and somewhat dusty. Even though corn syrup solids are packaged in multiwall paper bags they tend to cake and become hard during storage.

The above article dealing with corn sweeteners should be of interest to all of you who are making frozen desserts as syrup flavor was the prime criticism of the ice cream samples judged in our Frozen Dessert Short Course.

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