

SWEETENING POWER OF THE CORN SUGARS IN ICE CREAM

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The purpose of this paper is to present and discuss data upon the effective sweetness of the corn products, dextrose, enzyme-converted sirup, and corn sirup solids, when used with cane sugar in ice cream. The results obtained are in accord with the experience reported by many manufacturers, in that these products are shown to be more effectively sweet than previously published data have indicated.

There are a number of reasons why published sweetness values may be too low. Most of these values have been determined in water solution, and therefore may not be directly applicable to ice cream. Many of the studies concerning effective sweetness were made before the corn sweeteners were the highly purified products that they are today. Furthermore, the standards of comparison have not been uniform.

In a recent paper (2) it was shown that the sweetness of an ice cream could be considered as dependent upon the ratio of the sugar to total water rather than upon the ratio of the sugar to the total weight of ice cream, as has been generally believed.

Since this is the case, it is evident that useful data upon the relative sweetness of the corn sugars as compared with cane sugar, when they are used in ice cream, can be obtained by a study of the amounts of the corn sugars that must be used per unit weight of water in ice cream to obtain in the frozen product the degree of sweetness equivalent to that produced by a definite ratio of cane sugar to water. Since in the use of corn sugars in ice cream it is customary to replace only part of the cane sugar, the experiments were conducted upon ice creams in which from one-third to one-half of the cane sugar was so replaced.

A study of the literature concerning the relative sweetness of sugars indicated that no uniform basis of comparison had been used, and that frequently figures were given with no statement concerning the basis of computation. It is the custom to use cane sugar as the standard, giving it arbitrarily a sweetness value of either 1 or 100. In general, for determining the comparative sweetness of the other sugars in terms of cane sugar, three methods of comparison are in use. In one method the weight of the sugar necessary to make a given volume of water solution as sweet as the same volume of cane sugar solution of known concentration is determined. In another method the weight percentages of the two sugars that give equal

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sweetness in water are compared. A third method is to ascertain the comparative weight of a sugar necessary to sweeten a given quantity of water to the same degree as will a given amount of cane sugar. Of the three methods, the last would seem to be the most satisfactory, as it indicates the comparative weights of sugars that must be added to a given weight of water to obtain the same sweetness. It is certainly the most useful for ice cream studies, in which, as previously stated, the ratio of sugar to water is the true measure of sweetness.

Most of the work upon the sweetness of sugars in water solution was done with solutions so dilute that sweetness could just be detected. However, Dahlberg (1) has shown that the effective sweetness of sugars increases with concentration, and also that two or more sugars in solution together may give a greater effective sweetness than the sum of their sweetening values taken separately.

When ice cream is frozen, the sugar is concentrated into that part of the water not converted to ice. Therefore we might, from Dahlberg's experience, expect the corn sugars to be more effective sweeteners in ice cream than in the mix, due to this concentrating action.

As a preliminary experiment two vanilla creams of identical composition, except that one contained 15 per cent cane sugar and the other 10 per cent cane sugar and 5 per cent dextrose, were compared for sweetness. These creams were hardened at 0° F., then tempered to 15° F. for serving. The comparative sweetness then was determined by a jury of at least ten persons, as was done with all ice creams made during the series of experiments. Comparison indicated that the dextrose-containing ice cream was the sweeter. Numerous check experiments made upon similar samples, and also upon samples containing 13 per cent cane sugar compared with those containing 8.66 per cent cane and 4.33 per cent corn sugar, confirmed this observation. Two methods were then possible for ascertaining the actual effective sweetness of the dextrose. The first was to make up a series of mixes containing, for instance, 10 parts cane sugar and amounts of dextrose sufficient to give an ice cream as sweet as one containing 15 parts cane sugar on the assumption that the effective sweetness of the dextrose was 100, 110, 120, or 130 on the basis of 100 for cane sugar. These ice creams would then be compared for sweetness with an ice cream containing 15 parts cane sugar, to see which assumed value for the dextrose was correct.

The second method of comparison was to prepare a mix containing, for example, 15 per cent total sugar, dextrose and cane sugar, then to add increasing amounts of water to various portions, freeze the mixes and determine which ice cream had the same sweetness as the 15 per cent cane sugar control. With the sugar-water content of this mix known, the effective sweetness of the corn sugar could easily be calculated.

Both methods were used in a large number of experiments where the dextrose-cane sugar sweetened ice creams were compared with cane sugar sweetened ice cream frozen from mixes of 13 and 15 per cent cane sugar for vanilla ice cream and 15 and 18 per cent cane sugar mixes for chocolate ice cream.

The results of both methods applied to chocolate and vanilla ice cream indicated that dextrose monohydrate in frozen ice cream in the presence of cane sugar is one-fifth again as sweet as cane sugar, *i.e.*, it has a sweetness value of 120 compared with sucrose as 100. Under these conditions anhydrous dextrose would have a sweetness of 125.

Similar experiments, wherein the effective sweetness of corn sirup, solids and of enzyme-converted corn sirup was measured, gave sweetness values of 60 for the corn sirup solids and 75 for the solids (anhydrous) of the enzyme-converted corn sirup.

It should be emphasized that these figures indicate the relative sweetness of these corn products compared to cane sugar on a weight basis, that is, by comparing the weights of the corn products necessary to sweeten ice creams containing a given weight of water with an arbitrary weight of cane sugar used in a similar ice cream containing the same weight of water. The dextrose determinations were made where the material was substituted for one-third the usual cane sugar content of the mix; the corn sirup solids and the enzyme-converted corn sirup where they were substituted for half the cane sugar.

Since the corn sirup solids sweetness is 60, and the dextrose hydrate twice that, or 120, it becomes evident that a mixture of 1 part corn sirup solids and two parts dextrose may have the effective sweetness in ice cream of an equal weight of sucrose when it is substituted in amounts up to one-half the sucrose normally used. The effective sweetness of this mixture, in fact, was determined experimentally to be 100 under the conditions imposed.

For the sweetness of dextrose in ice cream, from experiments apparently made upon the mix, Dahlberg assigned the value of 89; for enzyme-converted corn sirup, 67; and for corn sirup solids, 49. His comparison was made on the percentage weight basis, however. If his data are translated to the basis employed in the experiments here described, the values become 88, 64 and 45, respectively. figures markedly lower than appear in these experiments. The values recorded here are, however, more nearly what would be expected from other data presented by him. He shows all three sugars to be at least as effectively sweet as cane sugar when mixed with cane sugar in the proportion of 1 to 2 in a total concentration of at least 40 per cent, a sugar concentration which most certainly would be exceeded in the unfrozen part of an ice cream at normal serving temperature.

The factors determining the final sweetness of an ice cream are many; one experimenter is reported to have a list of well over twenty. The results set forth in this paper, obtained under a rather narrow range of conditions, must not be assumed as applicable to all cases that may occur. On the other hand, the conditions of these experiments are sufficiently representative of ice cream practice so that it is believed that the values obtained for the sweetness of the corn sugar will be applicable in most cases.

It may be concluded, then, from these measurements upon frozen ice cream, that the corn sugars are markedly more efficient sweeteners in ice cream than has been indicated by previous measurements which have been made upon water solutions of these sugars. In fact dextrose hydrate, with a value of 120, is actually sweeter than cane sugar when it is used to replace one-third of the cane sugar in ice cream. The relative values for enzyme-converted corn sirup and corn sirup solids are 75 and 60, respectively.

REFERENCES

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