

## THE EFFECT OF SUGAR ON SOURNESS.

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P. N. EVANS.

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It is common experience that some foods and beverages taste less sour when sugar is added, and it seems worth while to seek an explanation of the fact.

In books of popular science the statement is sometimes made that the sugar "neutralizes" the acid—in some such way, presumably, as a base might. This explanation is untenable from the chemist's standpoint, inasmuch as sugar enters into no such reaction with acids.

Better informed writers sometimes aver that since sugar can not neutralize acids its value in such cases is only imaginary and not real. Since, however, in matters of taste, if the imagination is satisfied the problem is practically solved, it becomes of interest to know *how* the imagination is satisfied in this instance.

Sourness is now known to be a property of the hydrogen ion; for all acids, and acids only, are sour, and all have this constituent, and this only, in common, when dissolved in water. A diminution in intensity of sourness must therefore be due either to a reduction in the number of hydrogen ions in a given volume of the solution, or to a lessened sensitiveness to sourness on the part of the nerves of taste.

An investigation was made by the writer as to whether the introduction of sugar diminished the degree of ionization of hydrochloric acid in a given solution, using the freezing point method, and it was found that there was no effect, the degree of ionization of the acid being the same in the presence and in the absence of sugar.

The value of sugar, then, must depend on its physiological effect on the nerves of taste, not on any chemical action by which the concentration of hydrogen ions is reduced.

Some years ago Professor T. W. Richards of Harvard University (*Am. Chem. Jour.* 1898, 121), called attention to the delicacy of the sense of taste in detecting sourness and in comparing it in different intensities. With the assistance of Miss Carrie Richardson (now Mrs. C. E. Roth) the writer

made a series of over four hundred experiments in detecting acid in the presence and in the absence of sugar.

The experiments were conducted as follows: Solutions of hydrochloric acid of known strength were prepared, and equivalent solutions of sodium hydroxide were added gradually, the solution being tasted after each addition until sourness disappeared. In other experiments the acid was added to the alkali until sourness was noticeable. Both methods proved about equally delicate. As long as the solution was strongly acid or alkaline, only a drop or two was introduced into the mouth, but when the neutral point was almost reached a cubic centimeter of liquid was used and held in the mouth for a few seconds. The graduations of the burettes were hidden during every titration, that the judgment might not be prejudiced.

Experiments were made with solutions of acid varying from 0.715 normal to 0.0143 normal, or solutions containing 0.715 to 0.0143 milligrams of hydrogen ions per cubic centimeter. Sugar was added in quantities ranging from 0.04 to 0.8 grams per cubic centimeter.

With the experience gained in about twenty titrations considerable accuracy of taste had been acquired, so that consistent results were then obtained differing only about 1 part in 70 in a 15 cubic centimeter titration with the stronger solutions and in the absence of sugar, from those obtained with chemical indicators, the error being in almost all cases in the same direction, as might be expected—sourness disappeared with the addition of *less alkali* than the acidity as determined by phenolphthalein, or sourness appeared only on adding slightly *more acid* than required by the indicator. With the more dilute solutions, however, the *absolute* results were more exact. This is accounted for by the presence at the end point of less salt (due to the neutralized acid and alkali) in the more dilute solutions, the presence of salt reducing the delicacy of the sense of taste for sourness. With the most dilute solutions it was found possible to recognize with certainty the presence of 0.007 milligrams of hydrogen ions in the mouth, in 1 cubic centimeter of liquid, although 4 milligrams of salt were also present. In the most concentrated solution 0.01 milligrams of hydrogen ions was recognizable in the presence of 34 milligrams of salt.

The presence of sugar had the same effect as that of salt—the more sugar present in the solution the larger was the quantity of acid necessary for detection by taste; even the largest quantities of sugar used (0.8 grams per cubic centimeter) increased the necessary quantity of acid less than 1.5

times compared with that needed in the absence of sugar; 4.034 grams of salt was about as effective as 0.8 grams of sugar. In other words, if the mind is intent on noticing sourness, even large quantities of sugar do not seriously interfere. In the usual eating of sweet and sour food, however, the mind is, as it were, engrossed with the sensation of sweetness and rendered correspondingly less sensitive to other tastes.

In all probability any other powerful taste would be as effective in hiding sourness as sweetness is, but no other taste in concentrated form is so generally agreeable as sweetness. The sourness of lemonade would certainly be as thoroughly masked by highly salting it as by the addition of sugar; the result would not, however, be as agreeable to the majority of lemonade drinkers, probably.

In conclusion, brief reference might be made to a few experiments on the effect of sugar on bitterness, as sweetness and bitterness are commonly considered to be mutually exclusive terms—a thing can not be both sweet and bitter, though it can be at once sweet and sour. The experiments were made by the writer with mixtures of solutions of sugar and of quinine, but it was found impossible to obtain any numerical results, for, no matter what the proportion within very wide limits, the sensation of sweetness *preccded* that of bitterness, the mixture tasting sweet at the first moment and then bitter, the latter sensation being very lasting.

The use of sugar, then, to render sourness less intense, is based on a physiological, not on any chemical effect; the nerves of taste are less sensitive to one kind of taste in the presence of another, though the mind by concentration can largely overcome this obscuring effect.