THE INVERSION OF SUCROSE BY ACID MERCURIC NITRATE.

By C. B. Cochran.

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The work furnishing a basis for the following conclusions was undertaken for the purpose of investigating the conditions under which trustworthy results can be obtained by the use of Wiley's acid mercuric nitrate solution as an inverting agent for sucrose in the analysis of sweetened condensed milk. The normal sugar solution for the polariscope used is 26.048 grams made up to 100 cc.

The results of many experiments made on ½, ⅓ and ¼ normal solutions led to the following conclusions:

(1) Three cc. of acid mercuric nitrate should be contained in each one hundred cc. of the solution to be inverted.

(2) Inversion is best accomplished by standing flasks containing fifty cc. of the solution in boiling water for seven minutes (Harrison's method. See article by J. B. P. Harrison, *Analyst*, 1904, page 248). The time of heating may be prolonged to 8 minutes, but not more, as decidedly lower results will then be obtained.

(3) The inversion figure for a normal sucrose solution is —32.7 at at 20° C. This number is the average of four experiments made by myself. Harrison's experiments gave —32.68. The Herzfeld figure quoted by Harrison is —32.66. In my own work I have used Harrison's figure, since it is the average of the three results independently obtained.

(4) Temperature changes exert the same influence upon solutions of invert sugar whether the inversion is made by acid mercuric nitrate or by hydrochloric acid. Consequently, Clerget's formula for calculation of sucrose should be modified to read: sucrose $= \frac{100\,D}{132.68 - t/2}$ in which D = difference in polarization before and after inversion and t = temperature above 20° C.

(5) Acid mercuric nitrate exerts a decided inverting action on solutions of sucrose at ordinary temperatures. This inverting action is greatly diminished when the temperature of the solution is kept at or below 15° C.

A normal sucrose solution containing 3 cc. acid mercuric nitrate in 100 cc and polarizing + 100 when first prepared polarized + 96.2 at the end of 1 hour, the temperature being 24½° during the interval. A second solution polarizing + 50 when first made, polarized + 48.6 after one hour, temperature 22°.

A ½ normal solution maintained at 15° showed a fall in polarization of $^3/_{10}$ of a unit per hour, while another part of the same solution kept at 9° showed a fall of 14/100 of a unit per hour.

Solutions of sucrose at a temperature not exceeding 24° have not shown any reduction in rotation due to the action of acid mercuric nitrate when

the polarizations were made within 5 or 6 minutes after adding the reagent.

(6) Acid mercuric nitrate as employed for the inversion of sucrose has no influence on the polarization of lactose. This reagent can therefore be employed with safety in the analysis of sweetened condensed milk or in other solutions containing sucrose and lactose, provided the temperature of the solution is kept at or below 15° and the polarization is made as soon as possible after the addition of the reagent.

To three samples of milk in which the percentage of lactose had previously been determined by polarization known quantities of sucrose were added and the percentage of sucrose in each sample then determined by the use of acid mercuric nitrate as a clarifying and inverting agent.

Sample 1, contained 12.28%, found 12.14%.

Sample 2, contained 12.80%, found 12.80%.

Sample 3, 6.40%, found 6.33%.

These figures show that the method is capable of giving reliable results. Its simplicity and ease of execution commend it as superior to the more tedious and complicated gravimetric processes.

[CONTRIBUTION FROM THE BUREAU OF CHEMISTRY, U. S. DEPARTMENT OF AGRICULTURE.]

ESTIMATION OF LACTOSE AND BUTTER FAT IN MILK CHOCOLATE.

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Genuine milk chocolate consists of an intimate mixture of cacao mass or ground cacao nibs, sucrose, milk powder and cacao butter. In order to determine whether a so-called milk chocolate be true to name it is necessary to establish the presence of desiccated milk. This is accomplished by the estimation of lactose and butter fat. Reliance upon the lactose determination alone would lead to error in case glucose or other reducing sugar beside lactose were used in preparing the chocolate under consideration. Hence the estimation of butter fat becomes a valuable confirmation of conclusions drawn from the lactose figures.

In examining milk chocolate with the above purpose in view a rapid and accurate method for the determination of sugars is important. It is also desirable to determine lactose and sucrose in the same solution. Polarizing at 86° after inverting the sucrose was suggested and a method worked out on that basis.

It was first necessary to determine the effect of heating to 86° on the optical rotation of lactose. A number of solutions of lactose were polarized at 20° and at 86° and the necessary correction determined. The results appear in Table I.