A METHOD FOR THE ESTIMATION OF REDUCING SUGARS.

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In previous communications it has been pointed out that alkaline copper solutions in which carbonate is substituted for hydroxide are more delicate and specific as reagents for sugar detection than when alkalinity is secured by either sodium or potassium hydroxide, as in Fehling's solution. The carbonate gives ample alkalinity for the sugars to exhibit their full reducing power, but does not tend to decompose these substances, prior to their oxidation, to nearly so great an extent as does hydroxide.

The writer has previously proposed solutions for the detection and estimation of sugars, based upon the above stated observations. The first solutions suggested in this connection were delicate and specific for sugar work, but possessed the disadvantage common to so many of the copper reagents in that they were not permanent after mixing. Subsequently it was found and reported that a solution containing copper sulphate, sodium carbonate, and sodium citrate is more sensitive as a test for sugars than is Fehling's fluid, and unlike this latter solution, is not reduced by uric acid, chloroform, or the simple aldehydes. Furthermore, the citrate-carbonate-copper solution may be kept ready mixed without undergoing deterioration of any kind.

The present paper describes a modification of this solution which may be employed for the estimation of sugars. Like the writer's

1 Benedict: This Journal, iii, p. 101, 1907.
first solution for this purpose, this reagent is well suited to the ti-
tration of sugars because, upon its reduction, a white precipitate
of cuprous sulphocyanate is produced, which permits the end-point
of the reduction to be readily observed. The formula and tech-
nique for the use of this solution are given below.

The solution has the following composition per liter:

<table>
<thead>
<tr>
<th></th>
<th>grams</th>
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<tbody>
<tr>
<td>Copper sulphate (cryst.)</td>
<td>18.0</td>
</tr>
<tr>
<td>Sodium carbonate (cryst.)</td>
<td>200</td>
</tr>
<tr>
<td>Sodium citrate</td>
<td>200</td>
</tr>
<tr>
<td>Potassium sulphocyanate</td>
<td>125</td>
</tr>
<tr>
<td>Five per cent potassium ferrocyanide solution</td>
<td>5</td>
</tr>
<tr>
<td>Distilled water to provide a total volume of</td>
<td>1000</td>
</tr>
</tbody>
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With the aid of heat dissolve the citrate, carbonate, and sul-
phocyanate in enough water to make about 800 cc. of the mixture,
and filter. Dissolve the copper sulphate separately in about 100
cc. of water and pour the solution slowly into the other liquid,
with constant stirring. Add the ferrocyanide solution cool, and
dilate to exactly one litre. Of the various constituents, only the
copper salt need be weighed with exactness. Twenty-five cc. of the
reagent are reduced by 0.050 gram of glucose, or by 0.053 gram
of levulose.

Sugar estimations are conducted with the solution in the fol-
lowing manner: Measure 25 cc. of the reagent into a porcelain
evaporation dish (25–30 cm. in diameter) and add 10–20 grams of
crystallized sodium carbonate (or one-half the weight of the
anhydrous salt) and a very small quantity of powdered pumice
stone. Heat the mixture to vigorous boiling over a free flame and
run in the sugar solution quite rapidly until a heavy white precip-
itate is produced, and the blue color of the solution begins to
diminish perceptibly. From this point the sugar solution is run
in more and more slowly, with constant vigorous boiling, until the
disappearance of the last trace of blue color, which marks the
end-point.²

The following explanatory points may be added regarding the
solution. When ready mixed, like the qualitative reagent, this

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¹ One-half the weight of the anhydrous salt may be used.
² In applying this process to urine, the latter should be diluted, 1:10,
unless the sugar content is known to be very slight.
solution appears to keep indefinitely, without any special precautions, such as exclusion of light, etc. The trace of ferrocyanide is added to prevent precipitation of red cuprous oxide, which may be caused by certain impurities. Chloroform has such a marked tendency in this respect that it must not be present during the titration. The additional carbonate is added prior to the titration in order to provide sufficient alkalinity to insure the production of a sharp end-point.

As regards the accuracy of the process it may be noted that repeated determinations by different workers during the past year have convinced the writer that the method is probably more satisfactory than any other titration method for sugars at present available. Check determinations with the gravimetric (Allihn's) and polariscope processes have shown that the method gives highly satisfactory results, the figures in the various applications of it differing even less than those reported for the writer's previous quantitative sugar process. In this method, as in any other where the disappearance of color is made the end point, there is a tendency to run in an excess of the reacting substance unless special care is exercised throughout the titration and particularly at the end. The solution must be kept vigorously boiling over a free flame during the entire process, and towards the end the sugar solution must be added in portions of a drop or two, with an interval of about 30 seconds after each addition. Should the mixture become too concentrated during the titration process, distilled water may be added to replace the volume lost by evaporation.
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