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The oxidation of sugars by cupric acetate-acetic acid mixtures.

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The study was undertaken to learn precisely upon what the oxidizing powers of cupric acetate and Fehling's solution depended. The addition of acetic acid to cupric acetate diminishes its speed of oxidation so that one sugar after another ceases to be oxidized at a rapid rate as more acid is added. The amount of acid that may be necessary to check the oxidation to any given rate depends on the concentration of the acetate; the more concentrated the acetate the more acid is required. McGuigan determined the amount of acid necessary to check oxidation of the various sugars in different concentrations of the acetate within a certain time (one half minute's boiling). The results showed that the sugars arranged themselves as follows according to the amount of acid necessary to check oxidation. Levulose (most acid required), galactose, glucose, maltose, lactose.

Solutions of different concentrations of acetate and acetic acid were prepared which would just fail to oxidize levulose to a visible reduction of cuprous oxide on one half minute's boiling. Similar solutions were prepared for the different sugars. Each of these solutions for any given sugar of one per cent. concentration had the same speed of oxidation.

The cupric ions in these solutions were measured by the electromotive force developed between the solution and a plate of copper. The hydrogen ions were determined by the inversion of cane sugar. From the figures thus obtained the result appeared that in all solutions oxidizing any one sugar with the same speed the decomposition tension of the cupric oxide in the solutions was a constant.

For the different sugars the following data for decomposition tension were obtained in those solutions that just failed to oxidize to a visible extent in one half minute's boiling.

Levulose,	0.583 volts.
Galactose,	0.562 "
Glucose,	0.558 "
Maltose,	0.532 "
Lactose,	0.519 "

The constancy of the decomposition tension shows that in solutions containing different concentrations of cupric acetate but having the same rate of oxidation of any single sugar, the product of the concentration of the cupric ions and the oxygen ions is a constant, or $C_{Cu^{++}} \times C_{\overset{=}{O}} = K$. The fact that for the same rate of oxidation of the different sugars this product varies, shows that the per cent. of dissociation into reactive products of the different sugars also varies and in fact that levulose dissociates most, then galactose, glucose, maltose and lactose in a diminishing order. Preliminary observations indicate that for the same rate of oxidation, the product of $\overset{++}{Cu} \times \overset{=}{O} \times$ *dissociated sugar molecules* is a *constant.*

The oxidizing *potential* of all solutions containing cupric ions appears to be constant; these solutions differ only in their *rates* of oxidation. Acid cupric sulphate is reduced by glucose, levulose, etc., but at a very slow rate. The constancy depends on the constant ionic potential of the cupric ions, regardless of their concentration. This potential is 0.668 volt. Fehling's solution differs from a cupric acetate-acetic acid solution not in its potential but only in its speed of oxidation. The superior speed of action of a Fehling's solution over a cupric acetate solution is due to the enormously greater concentration of oxygen ions (hydroxyl ions) in the Fehling's solution and also to the fact that the dissociation of the sugar molecule into active particles is enormously greater in an alkaline than an acid medium. (Schade: *Zeitschrift für physikal. Chem.*, 1906, lvii, pp. 1–46. Nef's work on glycols, etc.)

These facts show why it is that the sugars are oxidized and fermented by the tissues, by moulds and bacteria at different rates, this being due to the greater dissociation of certain sugars. A cupric acetate-acetic mixture of proper concentration will show the same selective action toward levulose that many bacteria and other living organisms show and oxidize the levulose almost completely before the glucose is attacked. Whether sugars differ also among themselves in their reducing *potential* has not yet been determined. No indications of such a difference have as yet occurred to us.