Fehling's solution

Fehling's solution is a chemical reagent used to differentiate between water-soluble carbohydrate and ketone functional groups, and as a test for reducing sugars and non-reducing sugars, supplementary to the Tollens' reagent test. The test was developed by German chemist Hermann von Fehling in 1849.[1]

Fehling's test

On the left, the solution in the absence of reducing sugars. On the right, copper oxide, which would appear in the bottom of the solution if reducing sugars are present.

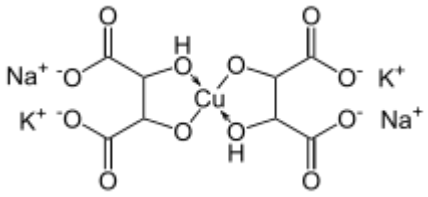
Classification	Colorimetric method
Analytes	Monosaccharides

Contents

Laboratory preparation

Fehling's solution is prepared by combining two separate solutions: Fehling's A, which is a deep blue aqueous solution of copper(II) sulfate, and Fehling's B, which is a colorless solution of aqueous potassium sodium tartrate (also known as Rochelle salt) made strongly alkali with sodium hydroxide. These two solutions, stable separately, are combined when needed for the test because the copper(II) complex formed by their combination is not stable: it slowly decomposes into copper hydroxide in the alkaline conditions. The active reagent is bis(tartrate) complex of Cu^{2+}, which serves as an oxidizing agent. The tartrate tetraanions serve as bidentate alkoxide ligands.

Use of the reagent



Structure of the main complex in Fehling's solution.

Fehling's solution can be used to distinguish aldehyde vs ketone functional groups. The compound to be tested is added to the Fehling's solution and the mixture is heated. Aldehydes are oxidized, giving a positive result, but ketones do not react, unless they are α-hydroxy ketones. The bistartratocuprate(II) complex oxidizes the aldehyde to a carboxylate anion, and in the process the copper(II) ions of the complex are reduced to copper(I) ions. Red copper(I) oxide then precipitates out of the reaction mixture, which indicates a positive result i.e. that redox has taken place (this is the same positive result as with Benedict's solution).

Fehling's test can be used as a generic test for monosaccharides and other reducing sugars (e.g., maltose). It will give a positive result for aldose monosaccharides (due to the oxidisable aldehyde group) but also for ketose monosaccharides, as they are converted to aldoses by the base in the reagent, and

then give a positive result.[2]

Fehling's can be used to screen for glucose in urine, thus detecting diabetes. Another use is in the breakdown of starch to convert it to glucose syrup and maltodextrins in order to measure the amount of reducing sugar, thus revealing the dextrose equivalent (DE) of the starch sugar.

Formic acid (HCO_2H) also gives a positive Fehling's test result, as it does with Tollens' test and Benedict's test also. The positive tests are consistent with it being readily oxidizable to carbon dioxide.

The solution cannot differentiate between benzaldehyde and acetone.

Net reaction

The net reaction between an aldehyde and the copper(II) ions in Fehling's solution may be written as:

$$RCHO + 2\ Cu^{2+} + 5\ OH^- \rightarrow RCOO^- + Cu_2O + 3\ H_2O$$

or with the tartrate included:

$$RCHO + 2\ Cu(C_4H_4O_6)_2^{2-} + 5\ OH^- \rightarrow RCOO^- + Cu_2O + 4\ C_4H_4O_6^{2-} + 3\ H_2O$$

See also

- Barfoed's test

References

1. H. Fehling (1849). "Die quantitative Bestimmung von Zucker und Stärkmehl mittelst Kupfervitriol" (https://babel.hathitrust.org/cgi/pt?id=mdp.39015026322084;view=1up;seq=486) [The quantitative determination of sugar and starch by means of copper sulfate]. *Annalen der Chemie und Pharmacie*. **72** (1): 106–113. doi:10.1002/jlac.18490720112 (https://doi.org/10.1002%2Fjlac.18490720112).
2. Fehling's Test for Reducing Sugars (http://www.uni-regensburg.de/Fakultaeten/nat_Fak_IV/Organische_Chemie/Didaktik/Keusch/D-Fehling-e.htm)

External links

- "Fehling's Solution" (https://en.wikisource.org/wiki/Collier%27s_New_Encyclopedia_(1921)/Fehling%27s_Solution). *Collier's New Encyclopedia*. 1921.

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