

solved on shaking the test tube, and the copper solution should be carefully added, agitating the test tube after each drop has fallen into the mixture, so long as the precipitate is easily redissolved, when the solution will have acquired a beautiful blue or green colour, but should be quite clear, and free from any precipitate; the contents of the test tube must next be heated to boiling, when, if sugar be present, an orange-red precipitate is first thrown down which, after some time, becomes reddish brown. The precipitate consists of the suboxide of copper.

Since uric acid and mucus will also reduce copper when they are boiled with its salts, a similar solution should be set aside in the cold; and if after the lapse of 24 hours, the reddish precipitate has fallen, sugar is undoubtedly present.

*Cautions.* Much difficulty is often at first experienced in arranging the proper proportion between the copper solution, and the liquor potassæ. If too much copper be added, which is the most common mistake, the potash cannot redissolve the precipitate first formed, which may then be mistaken for a precipitate of suboxide. The best rule to bear in mind is—always to have an excess of potash present, and never to operate except with a clear solution.

*Fehling's Test.* In consequence of the difficulty of properly adjusting the quantity of alkali and copper in Trommer's test, many practitioners prefer to use a solution in which the copper and alkali are present in the exact proportion necessary. This solution may be prepared in the following way; 65½ grains of crystallized potassio-tartrate of soda are dissolved in about 5 fluid-ounces of a solution of caustic potash, sp. gr. 1.12. Into this alkaline solution is poured a fluid prepared by dissolving 135½ grains of sulphate of copper in 10 fluid-drachms of water. The solution is exceedingly apt to decompose, and must always be preserved in stoppered bottles, and in a cool place. It is very often more convenient not to mix the alkali and copper until the solution is wanted for use. In this case a fluid-drachm of the sulphate of copper solution may be added to half a fluid-ounce of the alkaline solution prepared as above.

About a couple of drachms of the test-solution are poured into an ordinary test-tube, and the fluid boiled over a lamp. If no deposit occur, the solution may be used for analysis; but if a red precipitate be thrown down, the liquid has decomposed, and a fresh supply must be obtained. While the solution is boiling in the test-tube, the urine must be added to it drop by drop, and the effect watched. A few drops of urine which contains a large percentage of sugar will at once give a precipitate of yellow or red suboxide; but if no precipitate occur, the urine should be added to the fluid, drop by drop, any deposit being carefully looked for, until a quantity equal to that of the Fehling's solution employed, has been added. If no precipitate be found after allowing the test-tube to remain at rest for an hour, the urine may be considered free from sugar.

*Cautions.* (a.) The test solution should never be employed without previous boiling for a few seconds; the tartrate being exceedingly apt to decompose, and

the solution then reduces copper as effectually as would grape sugar.

(b.) The quantity of urine used in the test should never be greater than the quantity of test solution employed.

(c) After adding the urine in volume equal to the Fehling's solution, the boiling of the mixture must not be continued, as other substances, besides sugar, present in the urine, will reduce copper at a high temperature.

*Fermentation Test.* A few grains of German yeast are put into a test tube, which must then be filled with urine, and inverted in a shallow dish already containing a little of the urine, or better still, quicksilver, and set aside in a warm place, as a mantel-piece, or a hob. A similar test tube must be filled with water, a few grains of yeast added, and the whole subjected to the same conditions. If sugar be present, the formation of carbonic acid will, at the end of 24 hours, have driven nearly all the urine out of the test tube; a few bubbles only will have appeared in that containing the water. To prove that this gas is carbonic acid, some caustic potash or soda must be introduced into the test tube, when the gas will be quickly absorbed, and the urine again rise in the tube.

*Estimation by loss of density after fermentation.* Dr. Roberts has found that after fermentation, "the number of degrees of 'density lost' indicated as many grains of sugar per fluid ounce," and he proposes to estimate by this means the amount of sugar present.

About 4 fluid-ounces of the urine are placed in a 12-ounce bottle with a piece of German yeast of the size of a chesnut. The bottle is then set aside, very lightly covered, in a warm place, such as the mantel piece, or hob, and by its side, a bottle filled with the same urine, but without any yeast, and *tightly corked*. In 24 hours the fermentation is almost finished; the fermented urine is poured into a urine glass, and the specific gravity taken with urinometer; the specific gravity of the unfermented urine is also taken, and the specific gravity of the fermented is subtracted from the specific gravity of the unfermented, the remainder giving the number of grains of sugar contained in a fluid ounce; for example, if the specific gravity of the unfermented be 1,040, and that of the fermented 1,010, the number of grains to sugar in a fluid-ounce will be 30.

The researches of Brucke have proved that healthy man excretes daily through the kidneys about 15 grains of sugar.

*Clinical Import.* If the foregoing test announce the presence of sugar, in considerable quantity, whenever the urine is examined, diabetes mellitus may be inferred to exist. But should the presence of sugar in the urine be variable, and its amount small the fact is not of any known great diagnostic, or therapeutic, importance.

Some writers have asserted that sugar is present in the urine in all cases of impediment to the respiration, and in old persons; this statement, however, must be received with the greatest caution, since it has been contradicted by many excellent observers.