

## LXXIX. THE GLUCOSE CONTENT OF NORMAL URINE.

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THERE has been a long-standing impression that normal urine contains a small but definite amount of glucose. This idea has recently received substantiation from the results of Benedict and Osterberg [1921], who undertook to estimate the amount actually present. This was found to be within the limits given in the article of Schulz [1910]. Similar amounts to those obtained by Benedict and Osterberg were also found by Sumner [1924], using an entirely different method. Sumner stated that about 60 % of the total reduction was due to sugar.

The above results have not remained uncriticised by other investigators. Greenwald, Gross and Samet [1924] who give a résumé of the history of the problem came to the conclusion that the sugars of normal urine consist of difficultly assimilable carbohydrates or of reducing substances derived from protein.

Höst [1923] attempted to gain information on this point by preparing osazones from normal urine. He was able to show that aqueous solutions containing 0.0025 % of glucose yielded typical crystals of glucosazone and urine containing 0.01 % of added glucose gave characteristic crystals. By the same procedure crystals were obtained in normal urine, but their appearance was sufficient to differentiate them from the glucose compound. The difference between the physiological carbohydrate and glucose added to the urine was also shown in the rapidity of the fermentation with yeast. The physiological carbohydrate was only completely fermented after 48 hours at 37°. It is thus seen that neither Greenwald and his co-workers nor Höst believe that glucose is a constituent of normal urine.

Determinations of the reducing power and optical rotation of urine before and after fermentation have been made, but as Greenwald, Gross and Samet point out, no one has ever demonstrated the production of either alcohol or carbon dioxide in the process.

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During the course of a study of the fermentable carbohydrates of the blood we were led to examine the action of yeast on normal urine. For this purpose we used the larger differential manometer of Barcroft [1914] with mechanical shaking.

1 cc. of urine, which had been previously well shaken to expel dissolved carbon dioxide, was mixed with 0.5 cc. of a 1 % orthophosphoric acid solution. This was fermented with 0.2 cc. of a thick suspension of yeast placed in the smaller cup of the apparatus. The control flask contained 1.0 cc. of water and the same amount of yeast and phosphoric acid as in the reaction flask. The yeast used was the strain employed by Grafe and Sorgenfrei [1924] in their studies of the fermentable sugar of the blood and was the powerfully fermenting "Rasse XII" of the Institut für Gärungsgewerbe in Berlin. It was transferred each day to sterile beer wort and the 48-hour growth centrifuged and washed three times with tepid water. It was then suspended in saline. The fermentations were usually continued for 60 to 90 minutes at 30°. When glucose was added to normal urine the rise in the manometer was usually over in 45 minutes. Many of the tests were performed in quadruplicate and the concordance was very satisfactory. Using the constants of the manometers as obtained by the method of Münzer and Neumann [1917] the carbon dioxide yielded by the glucose on fermentation accounted for about 85 % of the sugar used.

In more than a dozen samples of normal urine we have never obtained a positive pressure in the manometer. Normal urines to which glucose (equivalent to a concentration of 0.05 %) had been added showed a rise within 10 minutes after addition of the yeast, the total rise being of the order of 30 mm.

That glucose excreted by the kidneys in very small amount is detected by yeast is shown in the following experiment where 50 g. of glucose were administered to a woman, aged 51, suffering from a severe form of Graves' disease, with a B.M.R. of + 80 %. The results are shown in the following table which is one of three practically similar experiments on the same patient.

Time	Blood sugar %	Sugar in urine (Benedict)	Rise in manometer mm.
9.00	0.088	0	0
10.30	0.256	±	131
11.30	0.120	0	0

50 g. of glucose at 9.05.

The amount of glucose excreted in the second sample of urine was barely enough to be detected with Benedict's reagent, and we were unable to detect any rotation with a small polarimeter reading to 0.1° and using a 200 mm. tube.

#### SUMMARY.

Using the differential manometer of Barcroft no carbon dioxide production has been found when normal urine is treated with yeast. This points to the absence of glucose from normal urine.

In the present form the manometric method appears to be among the most sensitive and selective means which we possess for detecting glucose in the urine.

## REFERENCES.

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