

ON A SIMPLE, RAPID AND ACCURATE GLUCOSE ANALYSIS WITH ONE DROP OF THE BLOOD, SERUM AND CEREBRO-SPINAL LIQUID USING TES-TAPE

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Most methods of blood sugar analysis employed routinely are troublesome to handle.

From the viewpoints of simplicity, speed and accuracy, the author investigated the use of Tes-Tape, employed widely in estimations of urinary sugar, for determinations of blood sugar content. But the Tes-Tape does not show colour reaction according to the amount of glucose when made to touch the blood directly. The writer however, succeeded in devising a method of estimation of blood sugar within 2 minutes by means of Tes-Tape.

TES-TAPE FOR SUGAR ANALYSIS IN THE BLOOD AND SERUM

For estimation of blood sugar content Kohn's method employing enzyme test paper is said to be of no practical use according to Saito. However, in case of serum sugar some test paper methods to give approximately accurate results have been reported by Seltzer, Baron, Oji and Shimada. However, even in this case there is inhibition of color presentation by the protein with resultant gradual decoloration. Hence, when the enzyme test paper is applied simply to the serum, there results no coloration based on the true content of sugar. Actually there is seen strong inhibition of colour when Tes-Tape is applied experimentally to egg albumin containing glucose. Hence, it becomes necessary to remove the blood protein when enzyme test paper is employed for estimations of blood sugar, and the solutions used for removing blood protein have not to interfere with the enzyme reaction.

SOME BASIC EXPERIMENTS

A. Salts

Twenty six common varieties of salts used in laboratories or pharmacies were mixed in glucose solution (100 mg/dl), and a study was made to find salts that do not interfere with the Tes-Tape reaction. These salt solutions were further tested with rabbit blood, and it was found that 1-2.5 g/dl zinc sulphate solution (pH 4.6) and mercuric acetate (with 0.1-0.25 ml. acetic acid

added, pH 3.4-3.2) were most suited for the removal of protein, and with no effects on the glucose or Tes-Tape. Needless to say these reagents by themselves, failed to produce the Tes-Tape coloration.

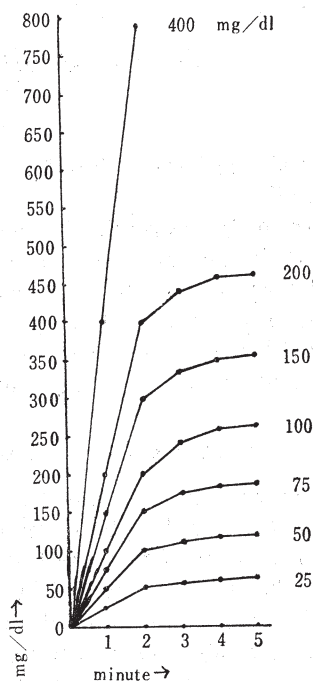
B. Time for reading the results

Next, an investigation was made to determine the time for reading the results, by examining the coloration of Tes-Tape at 24°C in glucose solutions of 25, 50, 75, 100, 150, 200 and 400 mg/dl strengths. The analytic values of sugar concentration at 1 minute intervals were found to show a definite curve, from the first to fifth minutes, with the value at the end of 2 minutes double that at the end of the 1st minute. But from the 3rd to the 5th minute the relation mentioned above was not seen. Hence, the reading of sugar content should be made in the 2nd minute after commencement of operation. As the blood is diluted twice with the solution used for removal of protein, this time corresponds with the 1st minute value of the original undiluted material.

C. Relation between room temperature and Tes-Tape value

Enzyme reactions are influenced by the pH of the solvent and room temperature. Experiments were made to study the effects of temperature, with Tes-Tape in glucose solutions of 100 and 50 mg/dl concentration. No effects were noted at temperatures of 20°C but below 20°C the colour presentation became feeble, and at 15°C the value was 10% lower, at 10°C 25% lower than the true sugar content.

Thus, at temperatures below 20°C there arise the need of correcting the values obtained; namely at 18°C the correction value is +1.5%, at 17°C +4%, at 16°C +7%, at 15°C +10%, at 14°C +13%, at 13°C +16%, at 12°C +19%, at 11°C +22% and at 10°C +25%.



Tes-Tape colour reading in glucose solution in every minute at 24°C.

METHOD OF ESTIMATION

0.02-0.03 ml of blood is accurately measured in a small pipette by ear puncture, and poured into a hollowed slide. An equal volume of 1 g/dl zinc sulfate solution is added and mixed thoroughly with a thin glass stick. The Tes-Tape is then immersed, and after 2 minutes the color is compared with the standard color chart, and the blood sugar content determined.

The standard color chart was prepared by sketching the color obtained by dipping Tes-Tape in glucose solutions of 50, 75, 100, 125, 150, 175 and 200 mg/dl for 1 minute at 20° C.

ESTIMATIONS OF SUGAR IN BLOOD, SERUM AND CEREBRO-SPINAL FLUID

Blood was examined in 22 cases, including 15 diabetic patients, serum in 19 cases including 5 diabetic and cerebro-spinal fluid in 20 cases.

In all cases, estimations by Somogyi's method were conducted in parallel. The values by the two methods were approximately equal or slight differences. The table below indicates the values obtained.

In case of serum when a 1 g/dl zinc sulphate solution was used, the 2nd minute values with Tes-Tape were somewhat lower than those by Somogyi's method, but when 2.5 g/dl zinc sulphate or mercuric acetate solution was used, the values coincided or were approximately equal.

Cerebro-spinal fluid can also be examined by the method used for blood. The sugar contents of the fluid in tuberculous meningitis and Japanese B encephalitis were found to be lower than those by Somogyi's method, when 1 g/dl zinc sulphate solution was used. In this case a 2.5 g/dl solution of zinc sulphate was found to be more satisfactory than the 1% solution. In the fluid of patients with appendicitis, the value coincided with that by Somogyi's method, even when a 1 g/dl solution of zinc sulphate was used.

The Value of Sugar in the Blood

Case No.	Sex	Age	Disease	Blood sugar mg/dl	
				Tes-Tape	Somogyi
1	♂	9	Normal	75	77.6
2	"	"	"	100	102.5
3	"	"	"	100	97.5
4	"	25	Diabetes mellitus	125	110.3
5	"	"	"	190	205.2
6	"	37	"	200	225.0
7	"	"	"	500	460.0
8	"	9	Normal	75	73.1
9	♀	42	Diabetes mellitus	88	85.6
10	"	45	"	130	125.0
11	"	"	"	250	255.0
12	♂	50	Normal	75	72.1
13	"	28	"	100	111.0
14	♀	29	Diabetes mellitus	100	105.1
15	"	45	"	130	110.9
16	"	"	"	138	134.6
17	♂	37	"	200	182.0
18	"	"	"	375	380.0
19	"	19	Normal	95	91.0
20	♀	50	Diabetes mellitus	163	145.4
21*	"	29	"	50	47.9
22	♂	25	"	140	134.4

* Coma, low blood sugar by insulin therapy.

SUMMARY AND CONCLUSION

A new, simple, rapid and accurate method of estimating the sugar contents in blood, serum and cerebro-spinal fluid by means of the enzyme test paper, Tes-Tape, is described. The results with this method coincided with the values obtained by the control Somogyi's method. This method is extremely simple to operate, requires no filtration, and can be completed within 2 minutes. It can be employed not only in the physicians office, at the home of patients, but also for mass screening of diabetic cases, as also in determining the existence of carbon monoxide poisoning and metalfever, said to show an increase of blood sugar concentration.

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