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A Novel Innovative Device for Qualitative estimation of Glucose, Protein and Specific Gravity of Fluid in Forensic Analysis.

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ABSTRACT

The main aim of the study is develop a cost effective device to detect glucose, protein and specific gravity of substance. A glass capillary tube with diameter 0.5mm and height 100mm was utilized. Height rise for different well-known fluid for that capillary tube is marked. The Benedict's reagent and Coomassie brilliant blue G250 was tested on cotton thread towards its inert state for these two reagents. At the opposite end of the tube a cotton thread was inserted which contended Benedict's reagent and Bradford Reagent (Coomassie brilliant blue G250) socked and dried on the thread. The device was tested the glucose sensitivity and protein sensitivity. This is a multipurpose device and can also be used to detect diabetes and kidney malfunction. Moreover, it can be applicable to circle round the cause which may kill the person by measuring blood specific gravity in its height rise scale. Moreover, it is the fastest, handy and most economic device which can find whether there is any chemical substitute for glucose or whether the water is pure for drinking purpose.

Keywords: glucose, Protein, Specific gravity, Diabetes, Kidney malfunction.

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INTRODUCTION

Specific gravity, glucose presence and protein presence, are three important parameters that can be used in numerous purposes. Specific gravity of a pure substance is fixed at constant temperature, pressure and solute concentration dissolved in it [1]. Specific gravity of pure water is always 1 at 4-20 degrees Celsius and 1atm. If there is some solute dissolved in it its specific gravity will constantly increase. It can be said that the specific gravity of a solution is directly proportional to the mass of the solute dissolved in it [3]. Capillary height rise decreases with increase in specific gravity of a solution [2,4]. It can be an important parameter to detect the purity of a substance.

Moreover, the capillary rise of urine can be used to detect diabetes and kidney malfunction. If the specific gravity of urine is high, there is good chance of diabetes [5, 6] or kidney malfunction [7] and it can be detected through capillary height rise. The main reason behind the rise of urine specific gravity increase in the case of diabetes is that kidney starts excreting excess glucose from blood to urine [3,5, 7]. This glucose raises the specific gravity of urine which ranges from 1.008-1.045. On the other hand if kidney is not functioning well then it starts excreting glucose and protein into the urine . This results the increase in specific gravity of urine and causes low capillary height rise.

Similarly, there are various substances like honey, oil, ghee, water etc. which purity gives a specific height rise. If the substance is pure it will give a constant height in a particular capillary at constant pressure and temperature. In today's world, purity and edibility of food items is a major issue which is tough to detect. Mostly, it requires heavy lab equipment, chemical and time to detect it [8]. In these situations capillary height rise detection is an easy, handy, cost effective and quick option to detect weather the substance is of our requirement or not.

Glucose is costly substance and it is used for various medical purposes. Sometimes, specific gravity of solution can be manipulated by adding unwanted solutes [8]. For example if capillary rise is showing the height range in that of diabetes and kidney malfunction, then it may be the result of dehydration. In this situation we need a qualitative test to conform the presence of glucose in urine.

Benedict's reagent is a very useful test to detect upon 1.000µg/ml of glucose [9,10].It is mainly used as solution in which 5ml reagent is used to detect 1.0ml of solution. This test can also be useful for diabetic patients to detect the presence of sugar up to a very sensitive level in their food substances. It can be a life protecting device for them. Furthermore, some sweet makers use artificial sweeteners instead of sugars to low their manufacturing cost. Sometimes these sweeteners can cause metabolic misbalance or even cancers [11, 12]. So this reagent is a brilliant option to identify the absence of sugars.

Water is the most used compound. Water purity and edibility is a major concern. Most of the life threatening diseases like typhoid and jaundice are caused by contaminated water [13]. A simple solution for this issue can be detection of protein in water sample. If we find protein in water it means that there is good chance of microbial presence in the water. Moreover, protein detection in urine can be a mode to detect kidney malfunction or renal infection [7].

There are various devices in market to detect specific gravity, glucose presence and protein presence. All of them are coastally and laboratory based technique. Currently, there is no device present in market which combines all three in one. This project is an initial step in this field and it is designed to be handy, easy and cost effective. It can be used to detect diabetes, kidney malfunction, dehydration, purity of substances, purity and edibility of food items and purity of water.

NOVEL DEVICE DESIGN

Novel device is based on physical and chemical principles. The physical part includes capillary action. The height rise depends on the specific gravity and surface tension of the liquid. As the composition of the substance chances, its specific gravity and surface tension changes. This leads to different height rise in capillary tube. A glass capillary tube with diameter 0.5mm and height 100mm was utilized. Height rises for some important substances like water, healthy urine, and oil were marked on the tube of diameter 0.5mm. Including the above marks a general scale was provided which could detect the difference of 0.050 specific

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gravity. A cotton thread of diameter 0.30mm and 3cm long was inserted from opposite end device. The first 1cm of the thread which was at the end of the tube was coated and deep absorbed and dried in Benedict's reagent. The other end of the thread was approximately in the middle the tube and was coated 0.5cm with Bradford reagent (Coomassie brilliant blue G250) and dried in air. All the work was performed in laminar flow at 37°C at normal pressure and humidity.

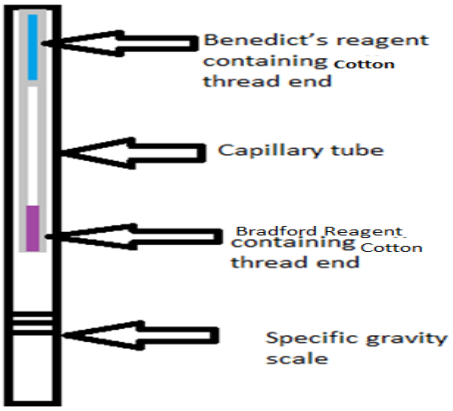

Figure 1: Novel design device Diagram (VIT- SS Equipment)

MATERIAL AND METHODS

Sample collection

5ml of urine was collected from 10 different students from VIT University. All of them were asked to drink 5litres of water per day before the sample was collected. The temperature of the environment was 37 degrees Celsius. Moreover, distilled water was collected from the VIT university lab and sunflower refined oil was collected from All mart in VIT University.

Capillary height rise Calculation

The capillary tube of diameter 0.5mm and height 100mm was taken. The height rise for all three substances was calculated. The capillary height rise for distilled water density is 1000 kg/m3, surface tension γ = 0.0728 N/m at 20 °C and g = 9.81 m/s2. The height rise of urine of having neither kidney malfunctioning nor diabetes was calculated which specific gravity ranges from 1.001 to 1.009 [14] and surface tension is same as water 0.0728N/m at 20 °C. Refined Sunflower oil specific gravity 0.9162 [15] while its surface tension is 7.39± 0.31[16]

The formulae used to calculate height rise is as follows:

$$h = \frac{2\gamma \cos\theta}{\rho g r},$$

Where, γ is surface tension, rho is specific density, g is gravitational acceleration. θ is the contact angle, and r is radius of tube.

Benedict's reagent and Coomassie brilliant blue G250 blue soaking on cotton thread:

To prepare Benedict's reagent 100 gram sodium carbonate was dissolved in173 gram citrate dihydrate and final volume was made to 850 ml with water. A solution of 17.3 g copper sulphate pentahydrate in 100 mL of water was added slowly using a string. A 100% cotton thread with diameter 0.3mm was taken. One end of it was soaked in freshly prepared Benedict's reagent and other end was soaked in Coomassie brilliant blue G250 up to lengths 1.0cm and 0.5cm respectively. The thread was inserted in the capillary tube so that the Benedict's reagent of thread was at the end of the capillary tube opposite to specific gravity scale and the Coomassie brilliant blue G250 end is 2.5 cm from that end and inside the capillary tube.

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Sensitivity test

A glucose solution of 0.001%, 0.005%, 0.010%, 0.050% and 0.100% weight/volume in distilled water was prepared. The device was dipped inside and soaked in the solution and it was shown flame for 20 seconds. The results were analysed. The Bradford reagent sensitivity was tested. A series of diluted solution of albumin protein in water was made [15.16]. The concentration were made 0.0100, 0.100, 1.000, 10.000 and 100.000 µg/ml solution were prepared. The results were absorbed.

Statistical analysis of Novel urine testing device efficiency

The height was tested with original substances. First of all, distilled water at temperature 15 degree Celsius was taken. The capillary tube of diameter was touched on the surface of water and capillary height rise was analysed. The same procedure repeated with 10 urine sample those were collected from VIT University and sunflower oil. The results were analysed statistically.

RESULTS AND DISCUSSIONS

Capillary height rise Calculation

The rise for the capillary tube provided were as follows: Water=2.96cm, Urine =2.93cm, Refined Sunflower oil =3.23cm.

Sensitivity Test

The device was sensitive up to 0.01% (weight/volume) glucose solution in distilled water. The results were visible upon 10.000µg/ml of the protein. Both the results can be considered as highly sensitive result.

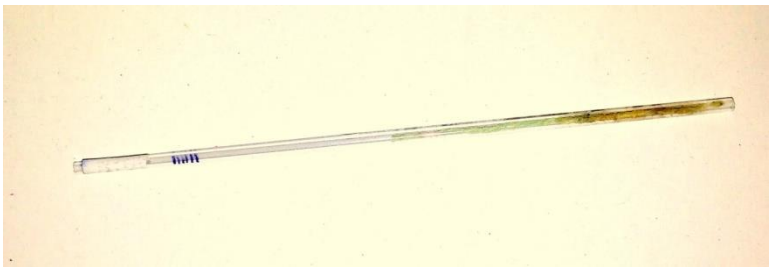

Figure 2: device showing glucose sensitivity test

Capillary Height Rise Statistical Analysis

The capillary height for distilled water came as 2.96 cm. The height rise of urine for normal person who drink 5litres of water per day comes between 2.96cm to 2.96cm which is in the range of calculated value.

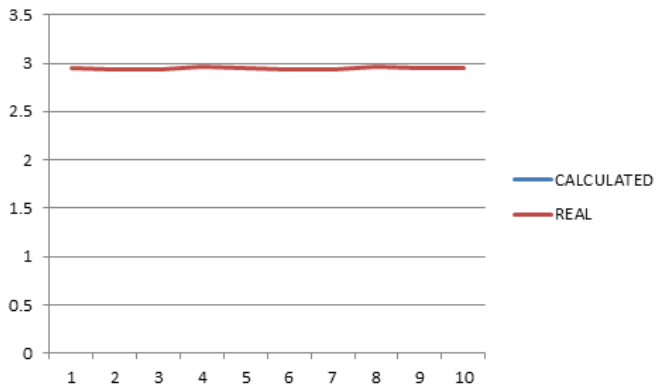

Figure 3: Capillary height rise of urine in centimetre

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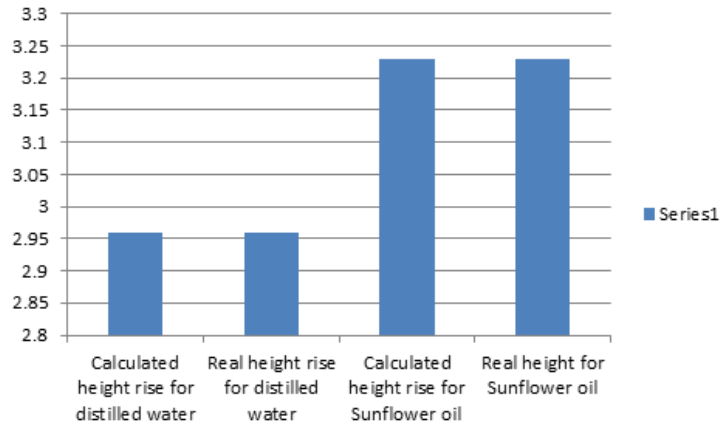

Figure 4: Capillary height rise comparison of calculated value and real height

The blue line denotes the capillary rise of urine sample for those people who did not have diabetes or kidney malfunction and they drank 5litre water per day. Their height range was 0.789 to 0.799cm and it was within the range of the calculated value. On the other hand the patients having diabetes, kidney malfunction and normal non-kidney malfunction, non-diabetic person who drank less than 5litre water per day are below 0.788cm.

CONCLUSION

The device is considered to be highly sensitive towards glucose and protein present in a solution. It is capable to detect 0.01% (weight/volume) glucose and 10.000µg/ml of the protein. Moreover, it also contains a specific gravity scale which can detect the purity of the substance. This scale can used to detect the specific gravity difference up to 0.01 levels.

As per the result we can say that its specific gravity scale is highly useful in detecting the purity of the substance like water, oil and urine. It can be highly useful in forensic, medical and daily use analysis.

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