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Saliva Sensor on Collagen Based Film to Detect Blood Sugar Level

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Abstract: Saliva is been increasingly observed as an attractive diagnostic fluid. This paper demonstrates one of the application of saliva in detecting blood glucose level. Though many different methods had been identified to measure blood glucose level this method particularly concentrated on salivary resistance of both diabetes and healthy person (Before and after fasting).A biological sensing element which is saliva based collagen from tannery solid waste is characterized for many bio sensing applications such as blood sugar level, harmone level (cortisol),cancer biomarkers……etc. The collagen thin film sheet was prepared from chrome shavings which is used as a substrate for identification of salivary resistance.Saliva(1µl) had been placed in contact with multimeter electrode on the collagen substrate where the transformation of biological response to an electrical signal displays the value on multimer digital screen. The value on the digital display has been related to find blood sugar level of every individual. After measuring under wet condition it's been air dried to measure under dry condition. Likewise procedure is been repeated under different concentration of oral fluid henceforth its resistance value has been recorded.

Keywords: Collagen, Saliva, Sample, Resistance, Blood sugar level.

Introduction:

Saliva is a suitable and noninvasive alternative to blood which is for biomedical diagnostic assays [1]. Saliva in humans is a oral fluid involving in different functions especially in oral health and homeostasis which plays a protective role in neutralizing acid in mouth and for lubrication of food. Saliva composition varies widely relating to the serous or mucous parts of glands [2]. Whole saliva contains weak and strong ions for offering buffer capacity. Some harmones which are commonly measured in plasma such ad steroids,peptides and protein hormonescould also be measured in oral fluid [3,4]. Saliva accurately reflects normal and disease states in humans. Its sampling benefits are some of the reasons for recognizing as an effective diagnostic fluid. In humans oral fluid (diagnostic fluid) is been secreted by three parts of salivary glands that includes paratid gland, sublingual gland, submandibular gland and also from large number of minor salivary glands. Each type of salivary gland secretes a special type of saliva with difference in concentration of salts,proteins,enzymes…etc. [5].Salivary output and its composition depend on autonomic nervous system. Generally, collection and identification of secretions from individual salivary glands used for detecting Gland-specific pathology(ie.Infections) [2,3].However since because of its easy sampling methods with or without stimulations. Whole saliva is more frequently studied, particularly for evaluation of disorders.

Method and procedure:

Step1: For preparation of desired collagen thin films here chrome shavings have been used. The preparation of collagen films is been presented in block diagram [Fig:1]

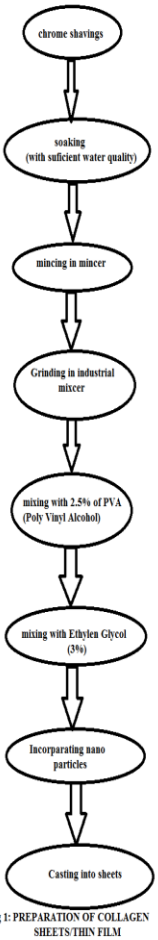

Fig 1: PREPARATION OF COLLAGEN SHEETS/THIN FILM

Figure 1: Collection of saliva sample

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Saliva can be easily collected from humans.Exact timing of sample collection was noted down. Before fasting sample is been collected by excluding brushing of teeth, and rinsing the mouth with water to avoid chewing gum or fluid indigestion.Before fasting six samples have been collected from different individuals based on different criteria such as healthy person without diabetes, person with diabetes,age,gender…etc. Likewise, six samples have been collected after fasting from the same individual.

Step 3: Collected sample had been analysed within 30 minutes because to keep the biomolecules active. The 1µl quantity of saliva sample is placed on collagen film. The multimeter electrode was kept in close contact with the sample inorder to measure the resistance value.

Step 4: After measuring the resistance value sample left undisturbed for several minutes to air dry.

Step 5: After drying in a dust free environment 2µl of same person saliva sample droped over the dried area. Resistance was checked by the multimeter and value noted down.

Step 6: After drying in a dust free environment 3µl of same person saliva sample droped over the dried area. Resistance was checked by the multimeter

Step 7: The same procedure have been repeated for other samples such as before fasting and after fasting of different individual.

Step 8: Resistance values where noted down and tabulated as in the table 1 below.

Table 1: Different person's saliva resistance value (Diabetes and Non-Diabetes Patient)

Names	Age	Gender	Resistance value (Before Fasting)			Resistance value (After Fasting)		
			1µl	2µl	3µl	1µl	2µl	3µl
Arumugam.V	75	Male	940.3	998.5	1520.6	1514	1678	1972
Ramalingam.M	55	Male	826.3	898.6	1298.6	1683	1893	1916
Nazar.S	50	Male	925.6	980.9	1780.9	1589	1617	1521
Shanthi.A	40	Female	825.5	1209.3	1623.4	1890.6	1993	1975.8
Sasikala.A	38	Female	790	825.3	1380.2	1432	1662	1721
Keerthana priya.R	20	Female	846	890	1230.4	1330.5	1280	1583

Experiment

Collected Samples were experimented by sensors and resistances were recorded. The values are shown in Table 1

Graphs related to resistance value:

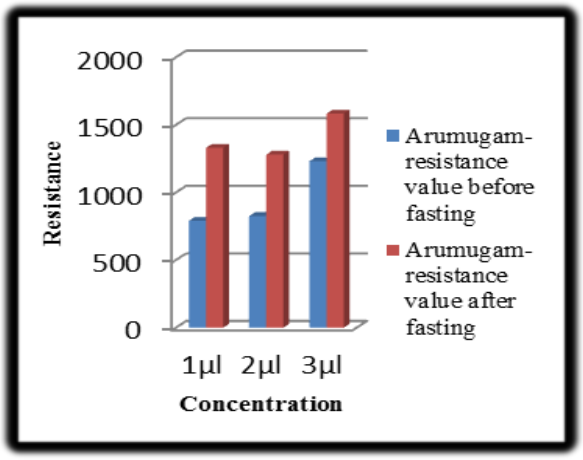

Fig (2a)

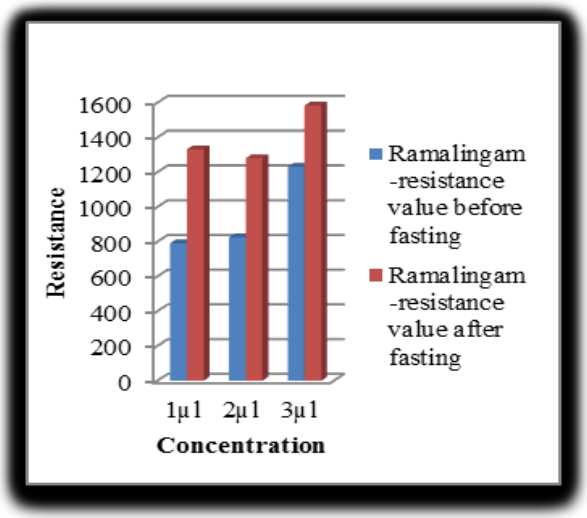

Fig (2b)

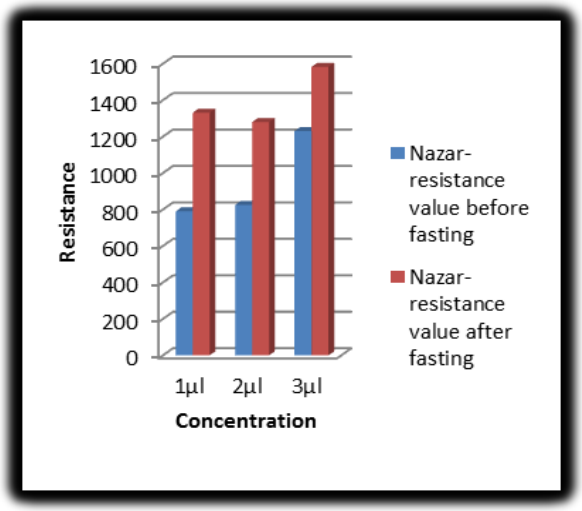

Fig (2c)

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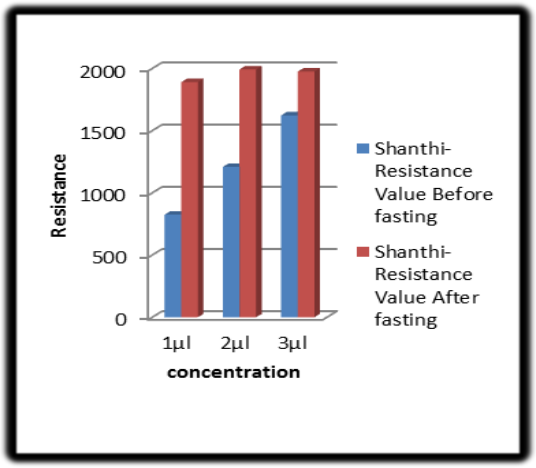

Fig (2d)

Results and Discussion

From Table 1, it can be seen that the minimum standard level of glucose in saliva corresponds to a range of 790 – 1432 µΩ before and after food respectively. The extreme values of the range again correspond to 120 mV and 160 mV respectively. Using these data, a calibration equation between age and resistance of saliva can be fitted as

$$\frac{C_g - C_0}{C_{g\max} - C_{g\min}} = \frac{R_g - R_0}{R_{g\max} - R_{g\min}} = \frac{V_g - V_0}{V_{g\max} - V_{g\min}}$$ where C stands for age, R for resistance and V for voltage. Suffix g stands for glucose and 0 describes standard or normal situation. max and min are maximum and minimum values in the table. C_0 has a value of 20 yr which is equal to C_{gmin} and $C_{gmax}$for a value of 20-70yrs for before and after food respectively. Similarly, R_0 or R_{gmin} has a value of 790-1432 µΩ; R_{gmax} is 1781-1976 µΩ. V_0 becomes 120 mV and Vmax becomes 160 mV.

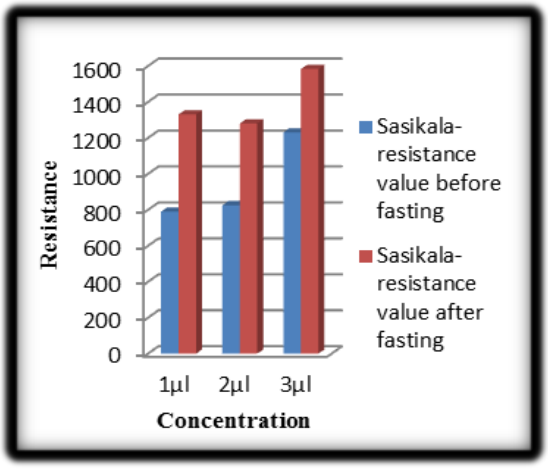

Fig (2e)

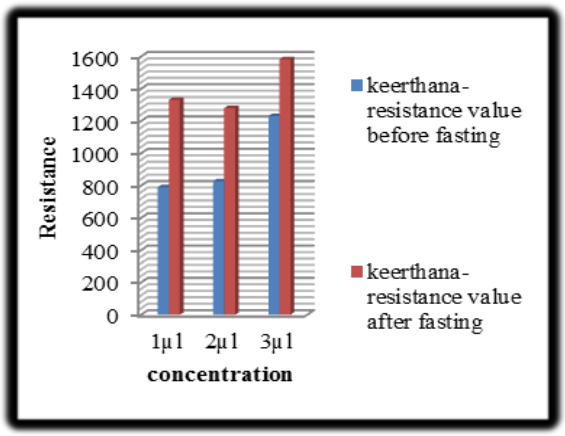

Fig (2f)

Using this equation, unknown values of resistances or voltage for an known aged (C_g) person / patient can be evaluated or predicted his/her glucose level before and after food respectively.

Conclusions:

Resistance value for the salivary samples was detected for before fasting and after fasting samples.The graph which has been constructed shows that the resistance value is less before fasting and it rapidly increased in after fasting samples. This indicates the concentration of glucose which intern necessary for blood sugar level is low incase of before fasting sample and increase in glucose level take place in case of after fasting samples. Eventually, the glucose level could also be detected by measuring the resistance value of the saliva samples henceforth like glucometer salivary detector could also be found in future inorder to make more simple and effective diagnosis.

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