AHC -07

Comparison of Point-of-Care Glucometers for Blood Glucose Determination in Cows, Goats and Fish

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Abstract
Point-of-care glucometers are widely used in glucose assessment in research and critical case management in animals because they are cheap, portable, fast and easy to operate as well as the use of small sample quantity. However, there have been concerns about overestimation or underestimation of results in certain species. This study compared the accuracy and reliability of two human point-of-care glucometers for blood glucose determination in cows, goats and fish. Blood was collected from the jugular vein of goats and cows and caudal vein of the fish with a hypodermic syringe and two glucometers were used to determine the blood glucose concentrations immediately. Thereafter, 1 ml was put into a clean test tube treated with ethylene diaminetetraacetic acid (EDTA) and the remaining 1ml was put into another clean test tube without anticoagulant. The samples were processed appropriately and plasma and serum harvested. Blood glucose test kit was used to measure glucose concentrations in plasma and serum by the glucose oxidase method. Data generated were analysed using correlation coefficient and one-way Analysis of Variance (ANOVA). Results showed that the mean value generated by Accu-chek active® was comparable with that of plasma and both were higher than that obtained in serum in cow and goats while TysonBio Evolve® over estimated the glucose by over 40% and 50% than Accu-chek active®/plasma and serum respectively.T hese results underscore the importance of validation of glucometers before use in any species.

Keywords: Glucose determination, point-of-care Glucometer, ruminant, fish

Introduction

Accurate and efficient blood glucose assessment is important in the clinical management of glucose disorders in man and animals (Higbie *et al*., 2014; Suvarnavibhaja *et al*., 2014) as well as in research (Mohsenzadeh *et al*., 2015. Point-of-care glucometers have become vital in glucose determination because they are cheap, fast in generating results and require no expertise (Lieske *et al*., 2002). It is also very useful in serial blood glucose monitoring because of their portability and use of very small quantity of samples. Although these devices have been found useful in some animals, reports of overestimation or underestimation of glucose values in certain species have been reported (Cohn *et al*., 2000; Lieske *et al*., 2002; Tauk *et al*., 2015). As a result of the variation in the values generated by these glucometers, assessment of individual species with individual devices is vital for accuracy and reliability of results (Burdick *et al*., 2012).

The study was therefore designed to compare the values generated by these two devices with the conventional laboratory method for comparability and accuracy

Materials and Methods:

Apparently healthy 20 goats, 20 cows and 30 fish were used for the study. The animals were individually restrained with minimal stress and about 2 ml of blood was collected from the jugular vein of goats and cows and caudal vein of fish with a hypodermic syringe. Blood glucose levels were determined immediately with the two glucometers. The blood samples were divided into two parts: 1 part was put into EDTA treated test tube while the remaining part was put into another clean test tube without anticoagulant. The samples with anticoagulant were centrifuged immediately while those without anticoagulant were allowed to clot at room temperature for 30 minutes and then centrifuged at 3000g and plasma and serum harvested.

Blood glucose was determined using the Accu-chek active® glucometer (Roche Diagnostics GmbH, Nannheim, Germany) based on the glucose dye oxido-reductase mediator reaction while TysonBio Evolve® glucometer (Tyson Bioresearch Inc., Chu Nan, Taiwan) was based on the glucose oxidase method. A test strip was inserted with the orange pad facing up into the glucometer opening for test strip and observed until a flashing blood image appeared on the glucometer screen. A drop of blood was put on the pad of the test strip using a capillary tube for Accu-chek active® while for TysonBio Evolve®, the test strip was placed to a drop of blood and the strip pad was filled by capillary action. The blood glucose concentration in mg/dl was displayed on the screen after 5 seconds in both methods. The results of both meters are equivalent to plasma glucose values (D'orazio*et al.,* 2005; Steffes and Sacks, 2005). The ranges of glucose concentration detectable were 10 – 600 mg/dl and 20 - 600 mg/dl for Accu-chek active®and TysonBio Evolve® respectively.

For the laboratory method, blood glucose concentrations were determined by GOD POD method based on the glucose oxidase method (Trinder, 1969) for *in-vitro* determination of blood glucose in serum or plasma (Quimica Clinica Aplicada,

Spain). Briefly, the working reagent (1 ml) was put into clean and labeled test tubes and 0.01 ml of serum or plasma sample was added to each tube, mixed properly and allowed to stand for 10 minutes at room temperature. A standard was prepared as described above. The absorbance of both the samples and standard were read against the contents of the blank at 505 nm using a Cole Parmer 1200 spectrophotometer (Cole-Parmer Instrument Co., USA).The glucose concentration was obtained with the formula below:

$$\frac{\text{Absorbance of sample}}{\text{Absorbance of standard}} \times \frac{100}{1} = \text{Glucose (mg/dl)}$$

The contents of the working reagent included Phosphate buffer (pH 6.8), p-Hydroxybenzoic acid, 4-aminoantipyrine, phenol, glucose oxidase, peroxidase, preservatives and stabilizers. The standard contains 100 mg/dl equivalent of glucose. Data generated were analyzed using correlation coefficient and one-way Analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS) version 16.0 for Windows (SPSS Inc., Chicago, IL). Variant means were separated using the Least Significant Difference (LSD) Method and significance was accepted at 5% probability level.

Results and Discussion

There were positive correlations among the groups. In cows, the mean value generated by Accu-chek active® was comparable with that of the test kit in plasma and both are significantly ($p<0.05$) higher than that obtained in serum. The mean value generated by TysonBio Evolve® was significantly ($p<0.05$) higher than all (Table 1). The same trend was also observed in goats and fish except that the values in serum and plasma were also comparable in goats while in fish, TysonBio Evolve® was over 40% and 50% higher than Accu-chek active®/plasma and serum respectively.

There were positive correlations between the plasma result generated with the test kit and all other methods**.** The values generated by Accuchek active® were comparable with the test kit in plasma. This is in agreement with reports of Mohsenzadeh *et al.* (2015) in pigeon. While the mean value generated in the serum was mildly lower than the plasma in cow, it still falls under the 15% range recommended by the American Diabetes Association (Cohn et al., 2000). The higher value obtained in plasma compared to that of serum is due to the immediate separation of the cells from the plasma as red blood cells have been known to consume approximately 10% of glucose within an hour if not separated. TysonBio Evolve® glucometer over-estimated the glucose concentration in these species, therefore is inappropriate for glucose determination in these animals as it could lead to misdiagnosis of their glycemic status and erroneous research conclusions. The results of this work are vital because of the negative effects of research findings obtained through erroneous results due to species variations and underscore the importance of validation of glucometers before use in any species.

Table 1: Blood glucose concentration of the animals determined with different methods

Methods	Mean ± standard error	Standard deviation	Minimum values	Maximum values
Cow				
Accu-chek®	57.80 ± 1.45^{a}	6.47	45.00	69.00
TysonBioEvolve®	70.90 ± 1.82^{b}	8.12	54.00	85.00
Serum	51.24 ± 0.85^{c}	3.80	42.86	54.14
Plasma	57.27 ± 0.73^{a}	3.28	52.38	64.29
Goats				
Accu-chek®	57.35 ± 2.06^{a}	9.20	43.00	80.00
TysonBioEvolve®	64.70 ± 2.41^{b}	10.77	51.00	91.00
Serum	49.10 ± 1.80^{c}	8.04	38.10	66.67
Plasma	54.31 ± 2.31^{ac}	10.33	42.86	78.57
Fish				
Accu-chek®	93.53 ± 2.92^{ac}	16.00	65.00	128.00
TysonBioEvolve®	145.27 ± 4.66^{b}	25.52	91.00	198.00
Serum	86.13 ± 2.52^{a}	13.80	61.90	119.05
Plasma	95.71 ± 2.74^{c}	15.02	69.05	123.81

^{abc}Different superscripts in a column indicate significant difference between the methods ($p<0.05$).

Conclusion

Accu-chek Active® glucometer can be used in cows and goats for blood glucose monitoring and research. Glucometers should be validated before use in any species.

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