

# EVALUATION OF PORTABLE GLUCOMETERS FOR USE IN RATS

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## Introduction

Various methods for measuring blood glucose concentration have been developed. Most commercial diagnostic laboratories use automated chemistry analyzers that determine glucose concentration by means of a hexokinase or glucose oxidase method. Other widely used methods for determining blood glucose concentration involve enzyme-catalyzed reactions coupled to a color determination system; oxidation-reduction methods and methods that result in generation of an electrical current. A number of portable blood glucometers have been developed for diabetic human patients to better regulate their blood glucose levels. These pocket-sized devices provide rapid, easy and inexpensive determination of blood glucose concentrations and require a very small blood sample. The use of the hand held devices in animals has been reported in dogs (1). In the biomedical research community, the extensive use of diabetic mouse or rat models requires a device that permits minimum amounts of blood given the size of the animals. The purpose of this study is to evaluate the analytical accuracy of the Bayer Ascensia Elite® and LifeScan One Touch Ultra® Glucometers used to measure blood glucose concentrations in rats.

## Materials & Methods

### Portable Glucometers

Ascensia ELITE®: Manufactured by Bayer HealthCare. Only 3 - 5 µl blood is needed. The test strip automatically draws in the right amount via capillary action. The test result is displayed in 30 seconds. The test strips are single foil-wrapped to stay fresh. One Touch Ultra®: Manufactured by LifeScan. The meter requires one microliter of blood for testing. The test strip also automatically draws blood and makes it easy to see when there's blood enough for an accurate reading.

The One Touch Ultra® delivers results in just 5 seconds. The test strips are available in quantities of 25, 50, or 100 packages.



### Animals

Ten males of each strain of ZDF obese rats (ZDF/CrI-Lepr<sup>fa</sup>), ZDF Lean Rats and CD Rats [CrI:CD (SD)] were used in the study. All thirty animals were 9 weeks old at the time of study. They were maintained in polycarbonate cages in a dedicated rodent procedure room that was kept at 21 ± 1 ° C with a relative humidity of 40-60% and a 12/12 hour light/dark cycle. All conditions of animal preparation and use are in accordance with recommendations set forth in the Guide of the Care and Use of Laboratory Animals. The animals are of a VAF/Plus® health status.



### Experimental Design

The three study groups were (1) 10 male ZDF fa/fa rats, (2) 10 male ZDF lean rats and (3) 10 male CD rats. Under gas anesthesia, 0.5 ml of whole blood was collected via tail snip of each of the animals. Immediately after the sample collection, drops of blood were applied onto the test strip of each of the two glucometers being evaluated according to the protocol specified with each unit. The remaining blood was placed into a tube containing heparin. To determine effects of the anticoagulant on glucose measurement, the heparinized whole blood glucose values were measured with both meters for the first half of animals in each group. The remaining heparinized blood samples in the tube were then centrifuged for plasma. For determination of the effects of sample types (whole blood vs. plasma) on glucose reading, the heparinized plasma glucose levels were measured with both meters for the

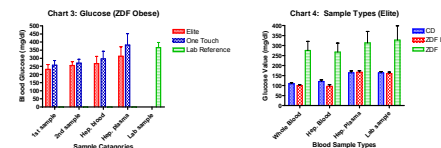
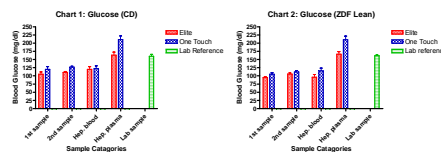
second half animals in each group. For comparison, the remaining plasma samples were clearly identified and submitted to a commercial laboratory for clinical analysis. To determine the within-run precision, five minutes after the first sample was collected, a second sample was taken from each animal, and the whole blood glucose levels were assessed with both meters.

## Results

**Whole blood samples:** The average difference of the glucose measurement between the two meters on the whole blood sample was 13 mg/dl (8.6%). For within-run precision testing, the glucose levels of the second samples averaged 13 mg/dl (8.5%) higher than the first samples for Elite, 9.2 mg/dl (5.5%) higher than the first samples for the One Touch Ultra® (Charts 1, 2 and 3).

**Effects of heparin:** The difference of the glucose values between the fresh and heparinized whole blood were 0.1 mg/dl for Elite and 3.4 mg/dl for One Touch Ultra®.

**Sample types difference:** The glucose in plasma samples were 33% and 50% higher than those in heparinized whole blood when measured with the Elite® and One Touch Ultra® respectively. The commercial lab values showed 51% and 38% higher than the glucose in whole blood measured with Elite® and One Touch Ultra® glucometer respectively. For plasma samples, the commercial lab result was only 1% higher than the meter reading with Elite® (Chart 4). However, the One Touch® readings were 23% higher than the commercial lab values.



## Discussion & Conclusion

One of the advantages of using the portable glucometers is the small sample requirement (3 – 5 µl). In contrast, a standard laboratory glucose analyzer requires about 25 µl of whole blood to test plasma glucose levels. The result from this study shows that the One Touch Ultra® reads slightly higher (8.6%) than the Ascensia Elite®. The within-run precision results indicate that the tests are reproducible. The variability may have come from the stress associated with repeated sampling as blood glucose values tend to increase slightly for the second sample. This finding agrees with a previous report (2). Because fresh blood without anticoagulant is normally used with portable glucometers and heparinized plasma is usually required for clinical analyzers, we evaluated any possible effect of the anticoagulant. The results showed that heparin does not have significant effect on blood glucose measurement. This finding is in agreement with a previous publication (1). The results of the study also suggest that the glucometers may underestimate the blood glucose concentration when compared with the commercial lab values. A few factors may have influenced these data. First, the blood glucose meters use whole blood while the clinical analyzer uses plasma samples. A previous study has shown that when plasma and whole blood samples are analyzed in systems that accommodate both plasma and whole blood, whole blood glucose values are lower (79-95%) than plasma values (3). One of the main factors influencing whole blood values compared to plasma is the

hematocrit. In the present study, hematocrit was not measured. However, a standard correction usually applied to whole blood samples for hematocrit is as follows: Whole blood glucose value = plasma value × [1.0 – (2.4 × 10<sup>-3</sup> × hematocrit%)] (2). When using whole blood samples with either of the two glucometers evaluated in this study, the following correction factors could be employed: Commercial lab value = ELITE Glucometer value × 1.51 and Commercial lab value = One Touch Ultra® Glucometer value × 1.38. If readout time is critical, the One Touch Ultra® provided faster results, 5 seconds vs. the Ascensia Elite®, 30 seconds. The One Touch® test strips are provided in vials that may pose a risk of exposure to light. Since the strips are light sensitive, such packaging may be less desirable. In contrast, the test strips for the ELITE® come singly packaged and avoid undue light exposure. In conclusion both glucometers have good precision and reliability and provide rapid evaluation of blood glucose levels. When measuring whole blood, the One Touch Ultra® provided a more accurate result. However, when using plasma samples, the Ascensia ELITE® gave results closer to those provided by the commercial lab.

## References

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