

Smartphone-based Colorimetric Urine Specific Gravity Measurement

Urine specific gravity is a commonly performed bedside test used to assess a patient's hydration status and renal function. Urine dipsticks which use a water soluble colorimetric reagent for measuring urinary specific gravity are convenient, easy to use, inexpensive, and inaccurate¹. Causes of dipstick specific gravity inaccuracy include the need to assess the reagent strip color at a specific time (45 seconds after immersion)² and using variable illumination. I-calQ's biosensor technology is able to address both of these limitations.

We used bromthymol-based colorimetric urine specific gravity dipsticks (OneStep Specific Gravity Test, Syntron Bioresearch, Carlsbad, CA.) and tap water to which varying concentrations of NaCl were added to obtain specific gravities of 1.004 and 1.030 as measured by a saline hygrometer. These values cover the physiologic range of urine specific gravity. Dipsticks were immersed in the saline solutions, positioned in a cassette, inserted into an i-calQ reader, and read using a smartphone app (Figure 1). This app incorporates a timer function (figure 2) so that strips are automatically imaged at the correct time point.

Images were acquired using a smartphone camera. Data analysis performed on each color channel of the resulting image calculated the average pixel value for each channel in the dipstick. To test for the effects of time on specific gravity measurement, we imaged the dipsticks at 5 (Figure 3) and 10 minutes (Figure 4). Pixel analysis shows measurable differences in all three color channels at both time points.

These observations demonstrate the ability of i-calQ's technology to read, analyze, and record colorimetric point-of-care clinical chemistry assays with precision and control which exceeds that of current methods for interpreting these widely used bedside tests.



Figure 1
Smartphone App for Measuring
Specific Gravity

References

1. *Arch Dis Child* 2001;85:155–157.
2. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CEEQFjAA&url=http%3A%2F%2Fwww.massgeneral.org%2Fpathology%2Fassets%2Fpoct%2Furine_VisualDipstickProcedure07_19_11.pdf&ei=uGmRUfDcMfyiQLe94DIDw&usg=AFQjCNHWC8bi_phHsDcJtiNMXrF24t_i9Q&sig2=rhIVgPKrLEkUfk6ohTyGRQ&bvm=bv.46471029,d.cGE

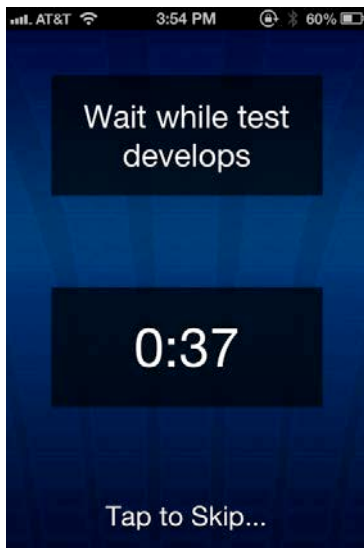


Figure 2
App Timer Screen

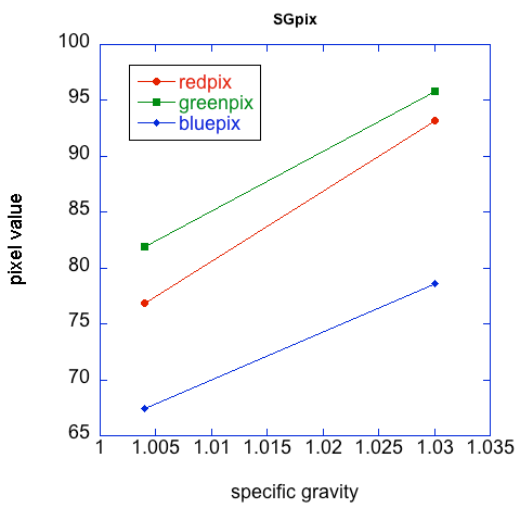


Figure 3
Specific Gravity Image
Analysis at 5 minutes.

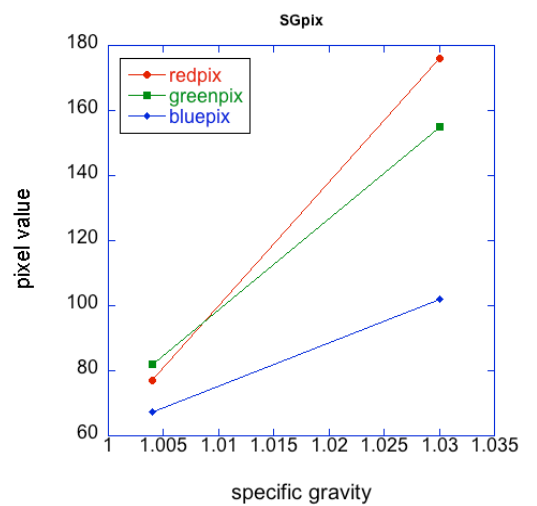
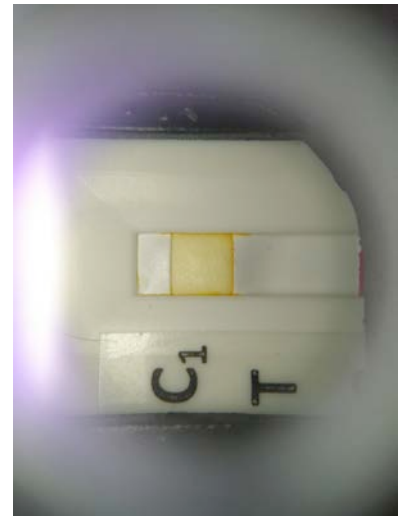


Figure 4
Specific Gravity Image
Analysis at 10 Minutes.