Research Template

Title: **Multi user testing of a pocket acidity refractometer (PAM) as a rapid means to determine titratable acidity in small fruits**

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Public Abstract:

Titratable acidity offers a means of estimating the sourness and sweetness of a fruit but is labor intensive and tedious, even when an automated titrimeter is used. A pocket sized digital meter (PAM) that quickly measures TA with minimal preparation was trialed for the small fruits blackberry, strawberry, raspberry, and blueberry in three laboratories. Results of the studies were mixed. For blueberries, the PAM yielded results slightly lower than those of the titrimeter. By using the PAM reading x 1.14, titrimeter values could be predicted within a range of 85% accuracy for blueberry. In contrast, blackberry PAM readings were slightly more than those of the titrimeter and PAM x 0.91 could be used to predict titrimeter values within 83% accuracy. Results from a third lab from strawberry and raspberry failed to yield a good correlation between PAM and titrimeter readings. Our results indicate that the pocket meter can be a very useful and rapid means of estimating titratable acidity in small fruits. Specific testing of the fruit will need to be done in each lab and the influence of harvest date or organic acid profile of the berry germplasm may also be important.

Introduction:

Titratable acidity offers a means of estimating the sourness and relative sweetness of a fruit, as it is often more closely related to taste than pH. The process of doing TA is labor intensive and tedious, even when an automated titrimeter is used. A digital meter was recently introduced which quickly measures TA with minimal preparation. In a preliminary study, we evaluated several small fruits and tomato for TA to compare readings of the digital meter to those of an automated titrimeter. Values between the two were highly encouraging.

In the current study, we expanded our tests from comparisons of titratable acidity on a small scale in a single lab to beta testing with two other labs. Blackberries from genotype composition tests at the University of Arkansas, representing 20 genotypes, were used. In a second test, four cultivars of red raspberry and strawberries were trialed at Virginia State University. Blueberry samples encompassing southern, northern highbush and rabbiteye germplasm were evaluated at NCSU.

Materials and Methods:

The PAM F5 (pocket acidity meters) from Atago (https://www.atago.net/english/products_bxacid.html). and bottle top dispenser were used by labs at VSU, NCSU, and UArk. Automated titrimeters were used at NCSU (Metrhom 862) and UArk (865 Mettler Toledo) and a single sample titrimeter (EasypH Mettler Toledo) was used at VSU.

The same protocol was followed by each lab. An aliquot of juice or puree was used to prepare a 1:50 solution by adding 1 g of juice and 49 ml (or g) of distilled deionized water (or 1.2 g and 59 ml water) and the solution mixed.   A 0.2 to 0.5 ml aliquot was placed on the refractometer (precalibrated with a 0.04%

citric acid solution) using mode 4 (strawberry setting) for strawberry and blackberry and the blueberry setting (mode 5) for red raspberry and blueberry. The remaining solution was titrated to an endpoint of 8.2 using 0.1 N sodium hydroxide using titrimeters.

Freshly harvested blackberry fruit were gently pressed by hand at UArk and fresh juice used to determine acidity. A total of 578 samples were tested from late May to early October. Strawberries were harvested from field and tunnel plantings in late May at VSU. Small samples of red raspberry (10) and strawberry (20) were tested at VSU. At NCSU, frozen blueberries representing southern highbush, rabbiteye, and northern highbush samples were thawed and ground to a smooth juice/paste with a genogrinder.

Results and Discussion:

For blackberries, a total of 578 samples were compared, using fresh blackberry juice from late May to October harvests. The range of titratable acidity was 0.3 to 2.0 and 0.3 to 1.8 % citric acid equivalents for titrimeter and PAM, respectively (Figure 1). Titrimeter readings are plotted against PAM readings, yielding a linear least squares fit equation of 0.91x and R^2 of 0.82. The difference between PAM and titrimeter readings were compared and 54 samples with a difference greater than 0.3 (about 4% of total samples) were dropped from the data set. A perfect match of PAM to titrimeter would yield a 1.00x; here, PAM readings for blackberry were slightly higher than titrimeter readings.

For blueberry, PAM readings were quite close to titrimeter values and value fit was strong with an R^2 of 0.85 (Fig 2.). A total of 96 readings were taken and 6 were dropped as outliers. Multiplying the PAM value by 1.14 should provide a titrimeter value within a 85% level of accuracy.

Strawberry and red raspberry PAM and titrimeter readings generally showed titrimeter values substantially higher than PAM values (Fig. 3,4). Strawberry values for PAM were about 60% of titrimeter values, although the inconsistency yielded a poor R^2.

Ideally, the PAM values should match titrimeter values. This was not always the case, and we could not predict what caused the outliers within each set of berries. In a few cases with blueberries, we repeatedly got different results even after mixing and running fresh samples for outliers. For blackberries, samples early in the season gave PAM results that were not in the best agreement with titrimeter values, but by August, results were much more similar.

Calibration of the PAM at least daily is needed and we will need to explore the need for more frequent calibration when over 100 samples are done in a day. The PAM yields results of only two decimal places while automated titrimeters yield four decimal places. If very precise values for titratable acidity are needed, such as in development of value added products, then an automated titrimeter would be the better choice.

By using a bottletop dispenser to measure out water volumes, the PAM method proved to be rapid. An added attraction is that two or three of these meters could be used by several people for minimal cost and further accelerate collection of titratable acidity data in the lab. Further, using a PAM does not require special chemicals or a specialized laboratory for use.

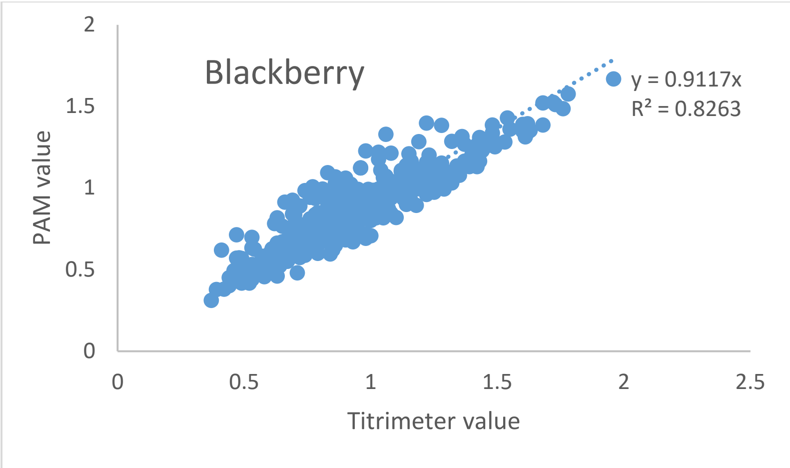

Figure 1. Blackberry titratable acidity (% citric acid equivalents) where values for PAM are regressed against those for the automated titrimeter (n=524).

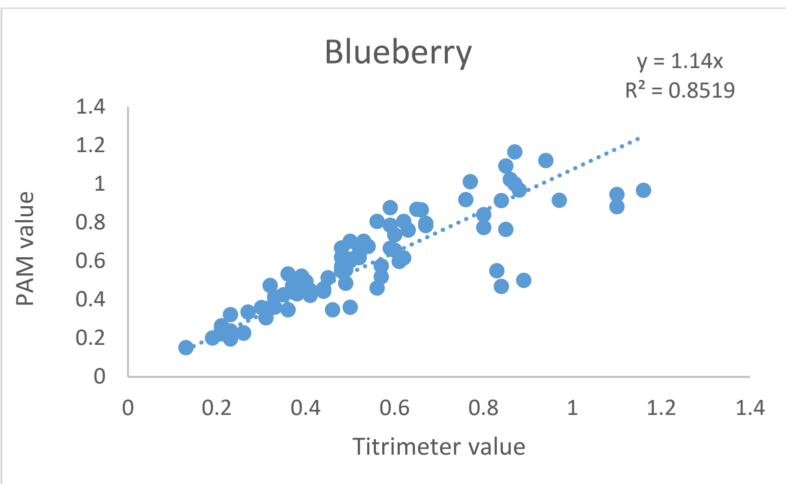

Figure 2. Blueberry titratable acidity (% citric acid) where values for PAM are regressed against those for the automated titrimeter (n=90).

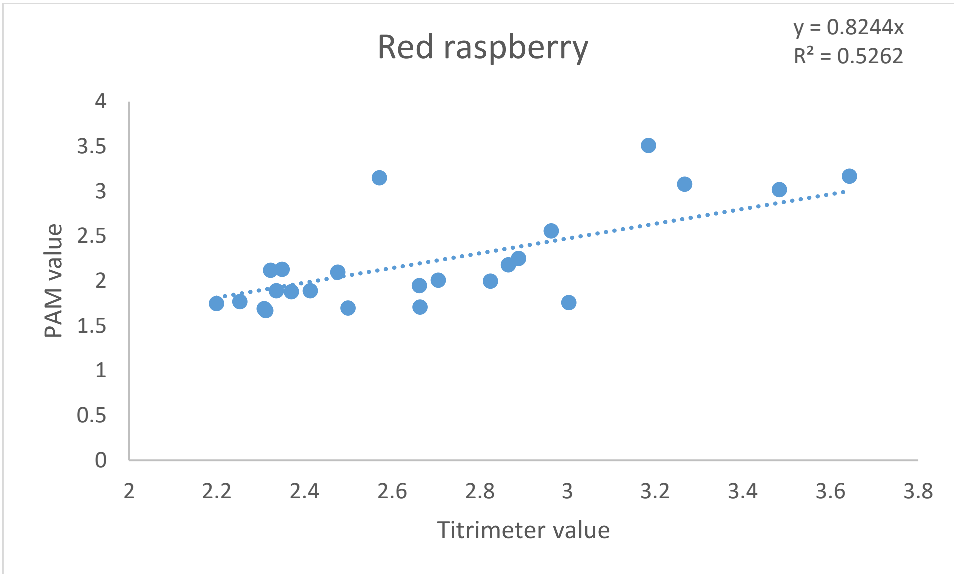

Figure 3. Titrimeter and PAM values for red raspberry (n=20

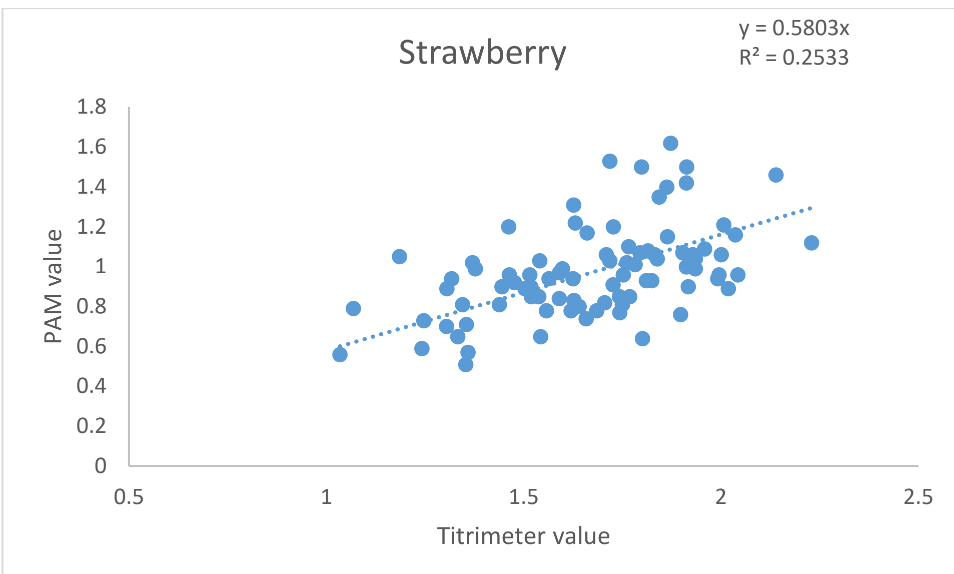

Figure 4. Titrimeter and PAM values for strawberry (n=85).