



Colostrum Management Tools: Hydrometers and Refractometers

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Topics include:

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Brix refractometer

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INTRODUCTION

Concentration of IgG in colostrum varies according to many factors, including a cow's disease history, volume of colostrum produced, season of the year, and breed. Research has shown that IgG levels vary widely from one cow to the next and range from less than 20 to over 100 mg/mL. The difference between 20 and 100 mg/mL of IgG in colostrum can mean the difference between failure and success in passive transfer of immunity. Colostrum containing 50 mg/mL or more of IgG is considered to be a high quality feed for newborn calves. Measurement of IgG concentrations in colostrum can be very useful in managing colostrum quality and monitoring colostrum feeding practices. Although high quality colostrum is typically very thick and creamy, appearance alone does not reliably predict IgG content. Volume of first milking colostrum also can be misleading and is not a recommended method for estimating colostrum IgG content. In addition, although IgG concentration can be measured very accurately in a laboratory, these tests are time consuming and not typically available to farmers. Hydrometers and refractometers can be used on the farm to estimate colostrum IgG, separate high quality colostrum from low quality colostrum, and improve your ability to provide calves with enough IgG to attain successful passive transfer of immunity. Colostrum containing > 50 mg/mL of IgG can be fed to newborn calves or stored for future use. Avoid feeding any other colostrum during the first or second feeding; lower quality colostrum can be mixed with transition milk and fed to calves that are at least two days of age.

HYDROMETER / COLOSTROMETER

The colostrometer is a hydrometer that measures specific gravity and, using a color-coded scale calibrated in milligrams per milliliter (mg/mL) of immunoglobulins (Ig), converts specific gravity to Ig concentration (Figure 1). The colostrometer is placed in a cylinder containing colostrum and allowed to float freely. Colostrum that tests “green” contains > 50 mg/mL of Ig, “yellow” contains 20 to 50 mg/mL, and “red” contains < 20 mg/mL of Ig.

Colostrum components other than Ig affect specific gravity, so this method is somewhat variable in its ability to accurately estimate Ig concentration. In statistics the R^2 value is used to describe the amount of variability that can be accounted for by a particular model. It ranges from 0 to 1, and the closer the value is to 1, the better it is at predicting results. In research investigating the colostrometer, the relationship between IgG and specific gravity has been reported to have an R^2 value of 0.3 to 0.4. The practical implication of the variability in the colostrometer measurements is that the exact values reported on the scale are of less value than the categorization by color. The colostrometer is best used to separate good quality colostrum from poor quality colostrum.

For greatest accuracy, the colostrometer should be used with colostrum at room temperature (72 °F). At lower temperatures, the colostrometer overestimates the IgG concentration; at temperatures above 72 °F immunoglobulin concentrations will be underestimated. Figure 2 can



Figure 1. Colostrometer floating in a sample of colostrum. This sample is in the green category and contains at least 50 mg/mL of Ig.

be used to correct colostrometer readings based on colostrum temperature. A spreadsheet that will generate a graph for correcting colostrum measured at other temperatures is available at <http://www.das.psu.edu/research-extension/dairy/nutrition/calves>.

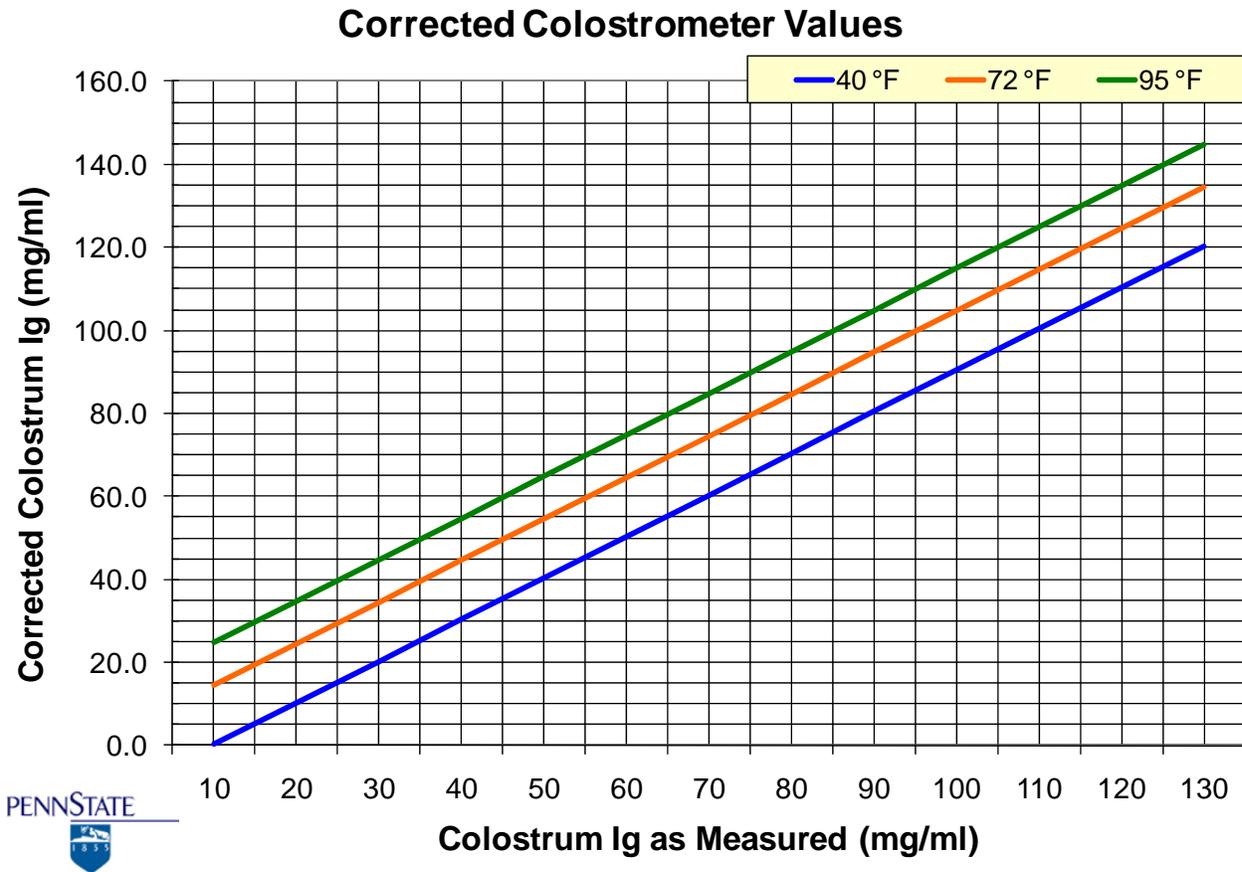


Figure 2. Chart for adjusting colostrometer readings depending on the temperature of colostrum. If colostrum is tested at refrigerated temperatures, use the blue line. At room temperature use the orange line, and at temperatures near body temperature, use the green line.

When using a colostrometer, it is important to remember that colostrum is a wonderful medium for bacterial growth. If an entire milking of colostrum is left to cool for two hours before measuring the IgG level, bacteria have had ample opportunity to multiply. Avoid rapid bacterial growth by pouring a sample of the colostrum into the measuring cylinder (only about a pint of colostrum is needed) and chilling the remaining colostrum immediately.

The colostrometer is available directly from the manufacturer at www.colostrometer.com. Nasco also sells the colostrometer, and it may be available from other farm suppliers. The colostrometer and a measuring cylinder can be purchased for less than \$100 and can be used on many colostrum samples. Use care when handling the colostrometer, as it is a glass instrument and is fairly fragile. If the instrument is broken, replacements are available separate from the measuring cylinder.

BRIX REFRACTOMETER

Recently, researchers have proposed that a Brix refractometer (Figure 3) can be used to measure IgG in colostrum. The scale in a Brix refractometer is designed to measure the amount of sucrose in a solution, but Brix values can be related to IgG in colostrum. Combined data from studies in Colorado and Canada found the correlation between a laboratory analysis for IgG using radial immunodiffusion, which is considered the gold standard of IgG analysis methods, and Brix refractometer values was 0.63. Using the same colostrum samples, the correlation between the lab test and a colostrometer was 0.36. In addition, testing colostrum at three different temperatures or using samples that had been frozen and thawed did not affect the results significantly. A Brix value of 22% corresponds to 50 mg/mL, meaning colostrum with a Brix value above this cutoff point can be considered high quality colostrum.

To use a Brix refractometer, a few drops of colostrum are placed on the prism and the sample cover is lowered. The refractometer is then held up to a light source, the instrument should be held perpendicular to the light, and the Brix value is read at the line between the light and dark areas that appear on the scale. When using a refractometer, the prism and sample cover must be thoroughly cleaned after every sample to avoid residue that could affect the next measurement. It is a good practice to check the calibration of the refractometer occasionally. The manufacturer should provide instructions on checking and adjusting the calibration, but distilled water should produce a reading of zero when the instrument is properly calibrated.

Many companies make Brix refractometers, and they are available in both digital and optical models. In research so far, the digital and optical Brix refractometers have provided similar results. However, the digital models may be easier to use. The high fat content of colostrum often causes a blurred band, rather than a distinct line, on the optical refractometer scale. This band can make it difficult to determine the exact Brix value and reduces the repeatability of measurements. Digital refractometers seem to be able to read these high-fat samples accurately. Brix refractometers are available for solutions with a wide range of sugar content. A scale that starts at 0 and goes to approximately 30 or 35 should provide a good range for testing colostrum. The cost of a Brix refractometer varies from less than \$100 to several thousand dollars, with many options in the low end of that range that will be suitable for farm use.

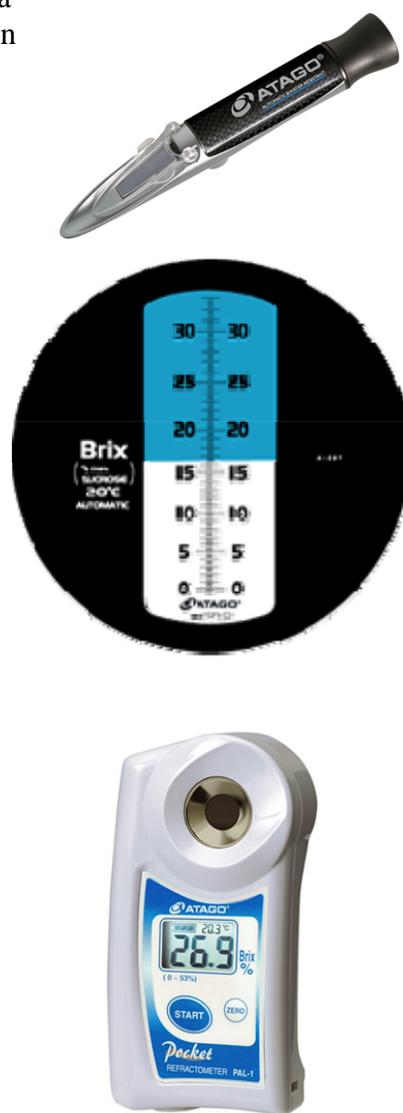


Figure 3. *Top:* an optical Brix refractometer; *Middle:* scale of the optical refractometer; the reading is taken at the intersection of the blue and white fields, in this case, 16.5%; *Bottom:* a digital Brix refractometer.

Emerging research suggests the Brix refractometer may provide an accurate method of estimating IgG in colostrum with the benefit of an instrument that is much less fragile than the colostrometer. Other research has shown the Brix refractometer can be used to determine the total solids concentration of waste milk, and work is underway to validate equations that will allow the Brix refractometer to be used to measure IgG concentrations in calf serum as well. In the near future a single instrument may be able to be used in several ways to assist in managing calf health.

Additional resources related to colostrum and other calf topics can be found at <http://www.das.psu.edu/research-extension/dairy/nutrition/calves>.

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