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Comparison of the use a refractometer Brix and colostrometry to estimate the quality of colostrum in dairy cows

Comparación del uso del refractómetro Brix y calostrometro para estimar la calidad del calostro en vacas lecheras

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Abstract

Colostrum is the first mammary secretion and in which calves can obtain passive immunity. This study aimed to correlate the quality of colostrum from high-yielding dairy cows using either a colostrometer or Brix digital refractometry (°Bx). Samples (N=340) of colostrum were taken from cows and analyzed with a colostrometer and Brix refractometry. A linear regression was performed. The coefficient of determination (R^2) was calculated. All statistical analyzes were done with the SPSS 25.0 statistical package. Means with colostrometer were 87.94±110, while with Brix refractometer they were 26.19±18, with R^2 0.706 and a P<0.0001. In conclusion, the refractometer and the colostrometer are effective methods to determine immunoglobulins. Brix refractometer had an acceptable correlation, which could be a useful tool for verifying the colostrum's quality next to the cow.

Keywords: colostrum, brix degrees, colostrometer, dairy cows.

Resumen

El calostro es la primera secreción mamaria y es la única forma en la cual las becerras adquieren inmunidad pasiva. El objetivo de este estudio es determinar la correlación de la calidad del calostro de vacas lecheras de alta producción medido con calostrómetro y refractometría digital de grados Brix (°Bx). Se tomaron 340 muestras de calostro del mismo número de vacas y fueron analizadas mediante el calostrómetro y refractometría de °Bx. Se realizó una regresión lineal simple y se determinó el coeficiente de determinación (R^2). Todo a través del paquete estadístico SPSS 25.0. La media de con calostrómetro fue de 87.94±110, mientras con refractometría Brix fueron de 26.19±18, con una R^2 0.706 con un valor de P<0.0001. En conclusión, las lecturas de refractometría y el calostrómetro, son métodos efectivos en determinar las inmunoglobulinas. El refractómetro Brix tuvo una correlación aceptable, lo cual puede ser una herramienta fácil de verificación de calidad de calostro al pie de la vaca.

Palabras clave: calostro, grados brix, calostrómetro, vacas lecheras.

INTRODUCTION

Colostrum is the first mammary secretion composed of several components (Baumrucker *et al.* 2010), such as antimicrobials, lactoferrin, lysozyme and lactoperoxidase, as well as immunoglobulins (Ig) that provide passive immunity to the newborn and growth factors that stimulate gut development (Menon *et al.* 2010). Calves are born agammaglobulinemic because the bovine placenta does not allow transferring Ig from mother to fetus during gestation (Godden, 2008), therefore the only source of immunity for calves is colostrum (Stelwagen *et al.* 2009). The most important factor influencing calf health and future production is to ensure proper intake of colostrum with high immunoglobulin content as soon as possible after birth (Bielmann *et al.* 2010). Therefore poor quality colostrum with inadequate immunoglobulin concentration contributes to failed transfer of passive immunity in calves, leading to increased morbidity and mortality (Drikic *et al.* 2018). Calf diarrhea and other digestive diseases account for more than 62 % of all pre-weaning heifer mortality (Baumrucker *et al.* 2010).

Moreover, IgG concentration is measured routinely in colostrum and calf blood 24 to 48 h after birth to determine colostrum quality (Gelsinger *et al.* 2015). Many methods have been used to assess colostral IgG concentration. However, improved and validated assessment tools are needed (Bielmann *et al.* 2010). Historically, radial immunodiffusion (RID) has been the only method that directly measures IgG (Gelsinger *et al.* 2015). However, reading colostrum quality with cow foot testing is determinant in decision making regarding colostrum quality. There are different methods to assess colostrum quality and the ones used at the farm level are the colostrometer and the Brix refractometer (°Bx). The colostrometer can be used for qualitative evaluation of colostrum or to estimate the amount of Ig (Fleenor & Stott, 1980). Colostrometer measures the specific gravity of a liquid. In the case of colostrum, specific gravity is highly correlated with total solids (TS), protein accounts for 64 % of TS and globulins account for 47% total protein (Fleenor & Stott, 1980). Therefore, the specific gravity of colostrum correlates with its immunoglobulin content (Bielmann *et al.* 2010). For its part, the °Bx refractometer is also a fast and convenient tool for grading colostrum quality (Bartens *et al.* 2016). Brix refractometry shows good potential to reliably estimate IgG concentrations in cow colostrum in multiple laboratories and can be recommended to aid in colostrum management decisions in dairy herds (Gamsjäger *et al.* 2020), in addition Brix refractometer is easy to use and it is a more specific tool to detect colostrum of adequate quality (Bartier *et al.* 2015). However, there are few studies comparing both methods to determine colostrum quality. Therefore, the objective of this study was to determine the correlation of colostrum quality of high-producing dairy cows through °Bx refractometer and colostrometry.

MATERIAL AND METHODS

General

All methods and handling of the experimental units used in this study were in strict accordance with the guidelines for the ethical use, care and welfare of animals in research at the international level (FASS, 2010) and national level (NAM, 2010) with institutional approval reference number UAAAN-UL/ 38111-425501002-2706.

Location of the study and animal management

The present study was conducted in a dairy farm in northern Mexico, located 103° 29'213" west longitude and 25° 92'199" north latitude, at an altitude of 1,100 m a.s.l, during the period of 2012-2014. This farm is located in an area with high diurnal temperatures in summer time (around 40 °C) and intense solar radiation, with low relative humidity (mean THI= 80 with a range of 69.8 to 85.0) and mean annual rainfall is 230 mm. Fresh colostrum samples (340) were collected from the same number of cows immediately after calving. Donor cows were from a herd of 2.300 Holstein cows from one to five lactations.

Colostrum collection and sample analysis

Colostrum was collected from each cow according to barn procedures using a milking machine after udder disinfection. Colostrum was collected immediately after calving. Colostrum samples (340) were collected from Holstein cows. For the samples analyzed by colostrometer (Kessler/Chase) 500 mL were used at a temperature of 22 °C, which has a specific density range of 1.027-1.076 which corresponds to 142-126.62 g/L of Ig. The colostrum quality classification was lower <1.036 (<24.35 g/L Ig), moderate 1.036-1.046 (24.35-49.82 g/L Ig) and high >1.046 (>49.82 g/L Ig) (Fleenor & Stott, 1980). Samples analyzed with the °Bx digital refractometer (MISCO Palm Abbe #PA203 US Patent 10880) with a measuring range of 0 to 56 %, 60 µL of colostrum at room temperature were used to fill the measuring disk and Brix percentage (%) was recorded to determine total solids (Quigley *et al.* 2013). The refractometer was calibrated using distilled water before use and washed with distilled water between samples.

Statistical Analysis

Data analysis was performed using the SPSS 25.0 statistical package, a simple linear regression analysis was performed and the coefficient of determination (R^2) was determined according to the following model:

$$\check{y} = \beta_0 + \beta_1 X$$

Where:

$\check{y}$ = Value of Y
β_0 = Estimated regression intercept
β_1 = Estimated regression slope
X= Independent variable

RESULTS

The results are shown in Figure 1. The correlation coefficient obtained in this study by regression analysis and is shown in Figure 1. Where it was found with an R^2 0.707 with a value of P<0.0001.

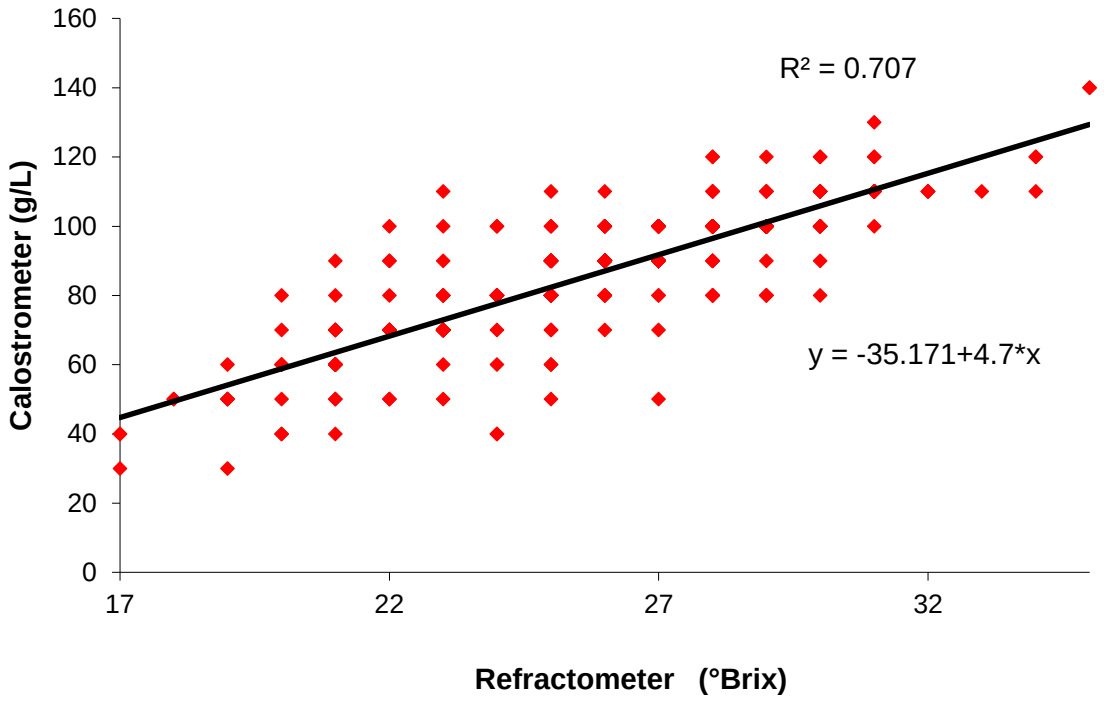

Figure 1. Regression analysis of the data obtained with the calostrometer (g/L) and the °Brix refractometer

DISCUSSION

In our study an r2 0.706 (P<0.0001) was obtained for both methods being equally effective in determining Ig levels in colostrum. Fleenor & Stott (1980) showed that the specific gravity measured by the colostrometer was closely associated with total solids (r^2 0.900) and immunoglobulin concentration (r^2 0.699). Currently, the colostrometer is the most commonly used tool to assess colostrum quality prior to feeding calves National Animal Health Monitoring System, 2010). However, Mechor *et al.* (1992), report its fragile design, and that the reading is strongly conditioned by the temperature of the colostrum at the time of analysis, make it less desirable as an on-farm tool. In addition, breed, number of lactations and month of calving (Morin *et al.* 2001) also affects density. Brix refractometers work well at any temperature (Bielmann *et al.* 2010). Digital refractometers estimate total solids by reporting a Brix value (refractive index measurement), which is then correlated

with colostral IgG or total solids concentrations (Chigerwe & Hagey, 2014). While Bartens *et al.* (2016), mention that Brix refractometers provided the most accurate assessment of colostrum quality and demonstrated excellent accuracy in terms of repeatability. Bielmann *et al.* (2010) suggest that the use of digital refractometer is very useful for measuring Ig concentrations in colostrum samples, and that freezing and thawing the samples does not alter the readings. Therefore, they show tremendous potential to be useful management tools to be included in a colostrum-monitoring program to improve the health of neonatal calves in dairy operations plus they are durable and affordable and the calibration process is simple.

The results of this study showed that colostrum from cows sampled with digital refractometer averaged 26.19±18 degree Brix. These values are close to the values reported by Bartier *et al.* (2015), they analyzed 569 colostrum samples and their result obtained was 24.3 as mean and range of 42.2. Morrill *et al.* (2015) reported mean values of 21.2 with range of 18.1; however, our results differ from the data obtained by Johnsen *et al.* (2019), who obtained refractometry reading of 19.7 ± 20.4. While Hassan *et al.* (2020) showed to be a little below the results obtained in this test, their values were 20.32 as mean and ranges of 26.9. These differences may be due to the different aspects that affect colostrum quality, mainly parity, days in the drying period, breed and feeding of the cows in the challenge period. On the other hand, the colostrometry data from our research was 87.94±110, which is similar to those reported by Bartier *et al.* (2015), who analyzed 519 colostrum samples and the mean was 82.3±140.

To provide optimal health for newborn calves, sufficient intake of good quality colostrum is essential. Brix refractometers provide quick and useful and convenient tools for grading colostrum quality (Bartier *et al.* 2015). Another advantage is the small amount of milk to be used (Buczinski & Vandeweerd, 2016). Brix refractometry shows good potential to reliably estimate IgG concentrations in cow colostrum in multiple laboratories and can be recommended to aid on-farm colostrum management decisions (Gamsjäger *et al.* 2020).

CONCLUSION

The Brix refractometer had an acceptable correlation with the values obtained with the colostrometer, which can be an easy tool to verify colostrum quality in a simple way. Therefore, refractometry can be an effective tool to replace the colostrometer.

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Errata Erratum
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