Field Determination of Colostrum Quality by Using a Novel, Practical Method

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The sugar or the alcohol refractometer allow a more precise, more repeatable and easier field assessment of the immunoglobulin (IgG) concentration in colostrum compared with the equine colostrometer. A good colostrum level (IgG ≥ 60 g/L) reads ≈16° when measured with the alcohol refractometer or 23% with the sugar refractometer. Authors' addresses: Institut National Agronomique—Paris-Grignon, 16 rue Claude Bernard, 75231 Paris Cedex 05, France (Chavatte); Institut du Cheval, Ecole Nationale Professionnelle des Haras, la Jumenterie du Pin, 61310 Exmes, France (Clément); Beaufort Cottage Stables and Laboratories, High Street, Newmarket, CB8 8JS, United Kingdom (Cash); and Ecole Nationale Supérieure Agronomique de Rennes, 65 rue de St. Brieuc, 35042 Rennes Cedex, France (Grongnet). © 1998 AAEP.

1. Introduction

Neonatal losses are very important in the equine species: a review of a large number of animals in France showed that ~12% of the foals died before weaning, half of which died in the first week after birth. Most of the neonatal losses were due either to dystocias or to infectious diseases in conjunction with failure of passive transfer (FTP). The importance of FTP has been acknowledged to be a major cause of neonatal disease in other countries, and it has been shown that only 70% of Warmblood mares have good quality colostrum. The quality of the colostrum has been shown to be the same or slightly better in draft mares compared with Warmblood mares.

One reliable method to prevent FTP is to make sure that the foal absorbs at least 1–1.5 L of good-quality colostrum (IgG > 60 g/L) in the first 6 h after birth. Specific gravity of colostrum is well correlated with IgG concentration, and colostrum quality is currently assessed in the field by using an equine colostrometer. In field conditions, however, this method is not very practical. For example, an amount of exactly 15 ml must be added to the chamber, and a slight error in the quantity of colostrum may alter the results, as it is difficult to measure viscous colostrum accurately. Moreover, it is relatively time consuming to wash the chamber and rinse it with alcohol between each measurement (in order to prevent leftover droplets of water from remaining in the chamber) as recommended by the manufacturer, and this often precludes a second reading. Finally, the results obtained may vary according to the temperature of the distilled water. Although calculations have been established to adjust the reading with water temperature, the method then becomes more cumbersome.

Protein solutions can refract light, and this prop-
property is used for measuring total proteins in plasma by using a refractometer. However, the range of protein concentrations measured with the current protein refractometer is not appropriate for colostrum. The sugar refractometer, however, has recently been shown to be in the right range of refraction and to provide an accurate measurement of colostral quality. The alcohol refractometer, currently used to measure the degree of alcohol in wine by wine makers, is based on the same principle and is readily available for individuals. It has yet to be tested for colostrum.

Finally, physical aspects of the colostrum may be related to IgG concentrations, as there are considerable variations in the color (gray, white, or yellow) and the consistency (viscous or liquid) of colostrum. Moreover, optical density may be connected to IgG concentrations. The aims of this study were to compare different field methods used to measure colostrum quality, and to compare the quality of colostrum between Warmblood and draft mares.

2. Animals, Materials, and Methods

A. Animals

27 Warmblood (mixed breed) and 12 draft mares (trait Breton) were used. All mares had been artificially inseminated the previous year, and the gestation had been confirmed by ultrasound at 20 and 40 days after ovulation. Mares were kept in a pasture at the Experimental Station of the Institut du Cheval in Chamberet (France) during gestation, and they were put in foaling boxes at night a few days before foaling, as assessed by using calcium strip tests. All mares were due between March 1st and May 31st. The quality of the immune transfer was evaluated at 24 h in 13 foals.

B. Materials and Methods

At the time of foaling (<15 min after parturition), a colostrum sample (25 ml) was milked from the mare for immediate evaluation, and 2 ml were frozen at −20 °C until analysis. The color (white or yellow) and consistency (liquid or viscous) was arbitrarily estimated by one of two technicians.

1. Field Evaluation of Colostrum Quality

The equine colostrometer was used according to the manufacturer's instructions. For the sugar and alcohol refractometer, a drop of colostrum was placed on the prism and covered with the glass cover. The measurement was read by looking through the eyepiece while in front of a light source. For the spectrophotometer, the colostrum was diluted appropriately (10 µl of colostrum in 4 ml of distilled water) and the optical density was measured between 540 and 550 nm. Foals were bled by jugular venipuncture at 24 h and the plasma was stored at −20 °C until use.

2. Laboratory Measurements

The IgG contents of colostrum and foal plasma were measured by immunoradiodiffusion by using a previously described method.

3. Statistical Analysis

Results were expressed as means ± SD. All foals were normal and suckled within 3 h after birth. The mean IgG concentration in the colostrum was 70.6 ± 31.7 g/L. There was no statistical difference between colostrum quality in Warmblood and draft mares, although the mean for draft mares was slightly higher than that for Warmbloods (75.1 vs. 67.7 g/L, respectively). Five Warmblood and three draft mares (33% of the total number) had low-quality colostrum (IgG of < 60 g/L).

Among the 13 foals that were tested, four suckled a low-quality colostrum (< 60 g/L). Only one foal had FTP (IgG plasma concentration of 1.8 g/L at 24 h, with colostrum IgG = 17.8 g/L). The three other foals had IgG plasma concentrations of 9.5, 7.8, and 13.4 g/L at 24 h, with a colostrum quality of 38, 47.2, and 54.4 g/L, respectively. All other foals but one had plasma IgG concentrations > 8 g/L (6.7 g/L for the last one). None of the foals suffered from infectious diseases within the first 2 months after birth.

A. Color and Viscosity

There was a significant difference between white and yellow colostrum for IgG concentrations (p < 0.05; Fig. 1). The immune transfer in foals did not differ significantly, however, in relation to the color of the colostrum. There were no significant differences for IgG concentration between liquid and viscous colostrum (Fig. 1).

B. Field Evaluations

1. Repeatability

The repeatability R, or the intraclass correlation, is used to estimate the precision of an individual measurement. A good repeatability (R > 0.8) means that only one measurement is necessary to obtain a reliable determination. Below a value of 0.8, it is necessary to perform repeated measurements to obtain a reliable determination.

Measurements obtained with the two refractometers were highly correlated (R = 0.99) and highly reproducible (R = 0.98 and R = 0.99 for the sugar and alcohol refractometers, respectively). The colostrometer measurements were less reproducible.
The repeatability of the measurements obtained with the spectrophotometer was not evaluated.

2. Reliability

Measurements made with the sugar or the alcohol refractometer were highly correlated with IgG concentrations ($R = 0.85$, $N = 20$, and $p < 0.0001$ and $R = 0.87$, $N = 20$, and $p < 0.0001$, respectively; Fig. 2). They were well correlated with the plasma level of IgG in the foal ($R = 0.66$, $N = 13$, and $p < 0.05$), and so was the IgG concentration ($R = 0.66$, $N = 13$, and $p < 0.05$). A colostrum with a level of 60 g/L read 16° with the alcohol and 23% with the sugar refractometer.

Colostrum densities measured with the equine colostrometer were less correlated with IgG concentrations ($R = 0.43$, $N = 25$, and $p < 0.05$) but were relatively well correlated with foal IgG ($R = 0.70$, $N = 13$, and $p < 0.05$). Optical density showed no relationship to IgG concentrations or plasma IgG levels.

4. Discussion

Although the color of the colostrum was related to colostrum quality, it is a very subjective parameter. Therefore, if the color were to be used as an indicator for colostrum quality, it would not be possible to rely on only this observation in the decision whether to supplement a foal with colostrum.

The relationship between colostral density and IgG concentration has long been known.6 The correlation described here between colostral density and IgG contents is not as good as that described in earlier studies, but the correlation with foal plasma IgG is slightly better.6,11 These discrepancies may be due to the field use of the colostrometer in the present study as opposed to laboratory measurements of thawed samples in previous reports. As mentioned earlier, the colostrometer is not very convenient to use. Moreover, the data presented here show that measurements are not very repeatable in field conditions.

Any solution containing dissolved solids will refract light rays. Refractometry measures the concentration of any solution of dissolved solids, based on the degree to which the light rays are bent (light rays are scattered by particles in suspension). The refractometer was easier to use than the equine

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![Fig. 1](image1.png)

**Fig. 1.** Relationship between the color and consistency of the colostrum and (a) its IgG concentration and (b) the plasma IgG concentrations in the foal at 24 h of age. The asterisk denotes a value of $p < 0.05$.

![Fig. 2](image2.png)

**Fig. 2.** Correlation between the measurement with the alcohol refractometer (in degrees) and the colostral IgG concentration. Regression line: $Y = 7.085 + 0.124 X$ ($r^2 = 0.739$, $N = 25$, $p < 0.0001$); the arrows show the confidence interval.
The threshold between a good-quality (>60 g/L) and a low-quality (<60 g/L) colostrum level was shown to be 23% with the sugar and 16° with the alcohol refractometer. These data are in agreement with the report by Cash8 (Table 1). When colostrum quality is poor, it is recommended that it be supplemented with good-quality colostrum. To date in France, lyophilized colostrum does not raise the plasma IgG concentrations in the foal to such a level that it may be preferred to fresh or thawed colostrum from a colostrum bank.

References and Footnotes


Table 1. Threshold Between Good-Quality and Poor-Quality Colostrum

<table>
<thead>
<tr>
<th>Refractometer</th>
<th>Good (≥60 g/L)</th>
<th>Poor (&lt;60 g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>&gt;16°</td>
<td>&lt;16°</td>
</tr>
<tr>
<td>Sugar</td>
<td>&gt;23%</td>
<td>&lt;23%</td>
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Proceedings of the Annual Convention of the AAEP 1998