Lactation in the Horse: The Mineral Composition of Mare Milk

H. F. SCHRYVER, O. T. OFTEDAL, * J. WILLIAMS, L. V. SODERHOLM AND H. F. HINTZ

Equine Research Program, Cornell University, Ithaca, NY 14853 and *National Zoological Park, Smithsonian Institution, Washington, DC 20008

ABSTRACT Changes in the mineral composition of mare milk during lactation were studied. Milk samples were obtained from five Thoroughbred mares one to three times weekly from the first to the eighth week of lactation and from two of the mares for an additional 8 wk. Samples averaging 500 mL were obtained after oxytocin was administered to the mares. Each sample was analyzed for total solids, ash, calcium, phosphorus, magnesium, sodium, potassium, copper and zinc. The concentration of all constituents except sodium and potassium decreased throughout lactation. The rates of decline of ash, calcium, phosphorus and magnesium concentration were similar, but the rates of decline of the other elements differed. Thus, the mineral composition of mare milk should be described in terms of the stage of lactation of the mare. The total solids and ash content of mare milk were 12 and 0.61 % respectively, at the end of the first week of lactation, 10.5 and 0.45 % at 4 wk, 10 and 0.38 % at 8 wk and 10.2 and 0.32 % at 16 wk. The calcium, phosphorus and magnesium concentrations at the end of the same periods were 1345, 943 and 118 µg/g of milk at 1 wk; 1070, 659 and 86 at 4 wk; 831, 574 and 58 at 8 wk and 700, 540 and 43 µg/g of milk at 16 wk. Copper and zinc concentrations were 0.85 and 3.1, 0.55 and 2.2, 0.29 and 1.9 and 0.28 and 1.8 µg/g of milk at 1, 4, 8 and 16 wk, respectively. J. Nutr. 116: 2142-2147, 1986.

INDEXING KEY WORDS horses • lactation • mineral composition

The organic composition of mare milk has been the subject of numerous investigations and reviews (1-3). A recent study reported that at midlactation (24-54 d post-partum) mare milk averaged 10.5 % dry matter, 1.29 % fat, 1.93 % protein, 6.91 % sugar and 50.6 kcal/100 g (4). However, studies of the mineral composition of mare milk have been few and scattered. Most studies were done many years ago before the advent of modern methods of mineral analysis. The following study was undertaken to provide information about the mineral composition of mare milk for a better understanding of the nutrition of the lactating mare and her foal.

MATERIALS AND METHODS

The composition of milk of five Thoroughbred mares was studied. The mares averaged 500 kg in body weight, varied in age from 11 to 20 yr and had borne 1 to 9 foals in previous years. The mares and foals for the present study were housed in box stalls. The mares were fed a mixed grain and molasses concentrate feed and a mixed alfalfa and grass hay. The grain mixture contained about 13 % crude protein; 0.5 % calcium and 0.3 % phosphorus (4).

Milk samples were obtained once on d 3,
RESULTS AND DISCUSSION

The average weekly mineral composition of mare milk is given in table 1. The concentration of total solids, ash and all elements was highest during the first week of lactation. The concentration of these constituents then decreased. The concentration of total solids decreased 12.5% during the first 4 wk of lactation, 5% during the next 4 wk and then remained constant for the next 8 wk. In contrast, the ash content of mare milk declined more rapidly, decreasing 26% during the first 4 wk, 16% during the next 4 wk and an additional 16% during the next 8 wk or approximately 50% in 16 wk. The decline in calcium, phosphorus and magnesium concentration in milk was similar to the decline in ash content probably because these elements comprise the largest component — about 40% — of the ash of mare milk (table 1). Calcium, phosphorus and magnesium decreased 20, 30 and 27%, respectively, during the first 4 wk of lactation, 22, 12 and 32% during the next 4 wk and 16, 6 and 26% during the next 8 wk. The total percentage declines were 48, 43 and 64%, respectively, for calcium, phosphorus and magnesium. The mineral ratios changed during lactation. The Ca:P ratio was 1.45:1 during the first week and 1.3:1 during wk 15-17. During the same periods the Ca:Mg ratio changed from 11:1 to 16:1.

The concentration of sodium and potassium in mare milk decreased about 30% during the first 4 wk, then fluctuated throughout the remainder of the 16-wk observation period. The percentage decrease in zinc concentration was 41% for the first 5 wk; thereafter the concentration of zinc remained constant. Among the minerals analyzed, copper displayed the greatest decrease in concentration, declining 35% in the first 4 wk, 47% in the next 4 wk and remaining constant for the next 8 wk.

Thus, the concentration and ratio of mineral elements in mare milk is continually changing and it is difficult to describe an "average" mineral composition of the milk. Linton (5) pointed out that a single sample...
### TABLE 1

**Mineral composition of mare milk**

<table>
<thead>
<tr>
<th>Weeks postpartum</th>
<th>Number of observations</th>
<th>Dry matter</th>
<th>Ash</th>
<th>Ca</th>
<th>P</th>
<th>Mg</th>
<th>K</th>
<th>Na</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>µg/g of fluid milk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>12.0 ± 0.17</td>
<td>0.61 ± 0.03</td>
<td>1345 ± 66</td>
<td>943 ± 46</td>
<td>118 ± 10</td>
<td>664 ± 158</td>
<td>237 ± 48</td>
<td>0.85 ± 0.40</td>
<td>3.1 ± 0.67</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>11.5 ± 0.52</td>
<td>0.57 ± 0.05</td>
<td>1317 ± 130</td>
<td>866 ± 61</td>
<td>108 ± 10</td>
<td>665 ± 117</td>
<td>196 ± 80</td>
<td>0.69 ± 0.30</td>
<td>2.7 ± 0.46</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>10.8 ± 0.32</td>
<td>0.51 ± 0.04</td>
<td>1160 ± 116</td>
<td>742 ± 42</td>
<td>92 ± 5</td>
<td>547 ± 156</td>
<td>184 ± 46</td>
<td>0.42 ± 0.16</td>
<td>2.4 ± 0.82</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>10.5 ± 0.44</td>
<td>0.45 ± 0.04</td>
<td>1070 ± 138</td>
<td>659 ± 58</td>
<td>86 ± 8</td>
<td>469 ± 117</td>
<td>161 ± 69</td>
<td>0.55 ± 0.25</td>
<td>2.2 ± 0.54</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>10.3 ± 0.27</td>
<td>0.42 ± 0.04</td>
<td>919 ± 101</td>
<td>615 ± 38</td>
<td>74 ± 5</td>
<td>391 ± 117</td>
<td>184 ± 68</td>
<td>0.46 ± 0.24</td>
<td>1.8 ± 0.40</td>
</tr>
<tr>
<td>6</td>
<td>14</td>
<td>10.3 ± 0.42</td>
<td>0.41 ± 0.06</td>
<td>931 ± 132</td>
<td>593 ± 68</td>
<td>69 ± 7</td>
<td>391 ± 117</td>
<td>184 ± 68</td>
<td>0.41 ± 0.08</td>
<td>2.1 ± 0.43</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>10.2 ± 0.63</td>
<td>0.40 ± 0.04</td>
<td>896 ± 84</td>
<td>600 ± 55</td>
<td>63 ± 8</td>
<td>430 ± 156</td>
<td>161 ± 46</td>
<td>0.34 ± 0.10</td>
<td>2.0 ± 0.49</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>10.0 ± 0.47</td>
<td>0.38 ± 0.04</td>
<td>831 ± 107</td>
<td>574 ± 39</td>
<td>58 ± 8</td>
<td>469 ± 78</td>
<td>138 ± 23</td>
<td>0.29 ± 0.11</td>
<td>1.9 ± 0.30</td>
</tr>
<tr>
<td>9-11</td>
<td>7</td>
<td>10.2 ± 0.10</td>
<td>0.37 ± 0.01</td>
<td>878 ± 124</td>
<td>580 ± 29</td>
<td>56 ± 8</td>
<td>356 ± 62</td>
<td>180 ± 57</td>
<td>0.22 ± 0.05</td>
<td>1.9 ± 0.31</td>
</tr>
<tr>
<td>12-14</td>
<td>5</td>
<td>10.3 ± 0.19</td>
<td>0.36 ± 0.03</td>
<td>779 ± 78</td>
<td>550 ± 64</td>
<td>49 ± 5</td>
<td>413 ± 81</td>
<td>115 ± 0</td>
<td>0.12 ± 0.06</td>
<td>1.7 ± 0.56</td>
</tr>
<tr>
<td>15-17</td>
<td>5</td>
<td>10.2 ± 0.49</td>
<td>0.32 ± 0.01</td>
<td>700 ± 51</td>
<td>540 ± 42</td>
<td>43 ± 2</td>
<td>341 ± 103</td>
<td>115 ± 0</td>
<td>0.28 ± 0.07</td>
<td>1.8 ± 0.53</td>
</tr>
</tbody>
</table>

1Values are means ± SD. 2Samples were obtained from five mares for the first 8 wk postpartum and from two mares from 9 to 17 wk postpartum. During the first week, samples were obtained on d 3, 6 and 7 from four mares.
Results of our study indicate that mare milk contains adequate amounts of the major minerals for foal growth. Assuming that the minerals in mare milk are readily available to the foal, mare milk can provide all of the calcium, phosphorus, magnesium, sodium, potassium, zinc, and copper needed by foals even in the absence of other non-milk food resources. Table 3 shows the body mineral stores of the whole body of foals at birth (8) and at 4 months of age (9). The mineral composition of mare milk cannot be said to be representative of lactation and that the stage of lactation must be specified in describing mare milk.

Previous studies have reported that the ash content of the milk of Arabian horses is lower than that of the milk of other breeds. In the present study, the ash content of the milk of Arabian horses was also lower than that of the milk of other breeds, as reported by Ullrey et al. (7). However, this difference may be due to the fact that the samples were obtained from Arabian horses of different breeds. Further studies are needed to determine the mineral composition of mare milk of different breeds of horses.

Table 2 shows the comparison of reported values for mineral components of mare milk. The composition of cow milk is influenced by the breed, age and nutrition of the dam, genetics, stage of lactation, season of year, temperature and other factors. Methods of sampling and analytical methods can also strongly influence results. However, with the exception of the low phosphorus concentration of the milk of Arabian and quarter horse mares reported by Ullrey et al. (7), our values are similar to those previously reported. In addition, our values for copper and zinc are similar to values reported by Ullrey et al. (8).

There has been little effort to determine differences in composition of the milk of different breeds of horses. Linton's study in 1931 (11) compared the content of ash and some organic constituents of the milk of 89 mares of 5 different British breeds and 53 crossbred mares. Linton noted only that the ash content of the milk of the heavy Clydesdale and Shire breeds was lower than that of the light Thoroughbred and Hunter horses. The comparisons shown in Table 2 also suggest little difference in the composition of milk of different breeds of horses. However, samples were obtained from horses of different breeds and analyzed under widely differing circumstances. Further studies are needed to define breed differences in the mineral composition of mare milk.
Foal body composition data from Meyer and Ahlswede (9) for newborn foals and Schryver et al. (10) for 4-mo-old foals. Mineral accretion is the difference in body mineral composition between birth and 4 mo of age. Mineral intake from mare milk is the accumulated grams of mineral for 120 d of lactation, assuming a mineral composition of milk similar to that found in this study and milk intakes by foals similar to that found by Oftedal et al. (1983).

Foals generally obtain minerals from other feed sources during the first 4 mo of life. However, the data in table 3 suggest that mare milk alone is an adequate source of the major minerals required by the foal.

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LITERATURE CITED


