Blood Lactate Concentration During Exercise in Horses Fed a High-Fat Diet and Administered Sodium Bicarbonate

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EXPANDED ABSTRACT

Indexing Key Words:
- horses
- lactate
- exercise
- high-fat diet
- sodium bicarbonate

Blood lactate concentration ([Lac−]) is the net result of appearance and clearance of the metabolite through production and metabolism. The pyruvate dehydrogenase (PDH) complex is a key regulator of fat and carbohydrate metabolism and can affect muscle and blood [Lac−] during exercise. Studies in skeletal muscle and heart have shown that glucose uptake, glycogenolysis, glycolysis and pyruvate oxidation are partially inhibited by the oxidation of fatty acids (Jansson and Kajiser 1984, Randle et al. 1963). Extracellular alkalosis also affects blood lactate concentration by increasing the magnitude and rate of lactate efflux from muscle during contraction (Mainwood and Worsely-Brown 1975, Spriet et al. 1986, Seo 1984).

Methods. Eight Arabian horses were randomly assigned to one of two diets (control or high-fat), conditioned and subjected to two repeated sprint exercise tests as described in a companion abstract (Ferrante et al. 1994). Two hours before the exercise test, two horses from each diet group received sodium bicarbonate (NaHCO3; 300 mg/kg body weight) dissolved in water (4 l); the other two horses received equal volumes of water. Venous jugular blood for whole blood lactate analysis was obtained at rest and 15 s before the end of each sprint. Data are presented as means ± SEM. Analysis of variance for repeated measures was used to evaluate the effects of diet, treatment, exercise (sprint number) and their interactions during the exercise test and exercise sequence (period).

Results and discussion. Blood [Lac−] increased during each sprint and remained elevated. The largest increases occurred during sprints 1 and 2 and to a lesser extent with further sprints. Blood [Lac−] was higher (P = 0.0240) during exercise in fat-adapted horses (6.58 ± 0.36 mmol/1) compared with horses fed the control diet (4.76 ± 0.23 mmol/1). Blood [Lac−] was higher (P = 0.0024) when horses received NaHCO3 (3.20 ± 0.36 mmol/1) than when horses received water (2.28 ± 0.25 mmol/1), regardless of diet. During exercise, blood [Lac−] was greater in fat-adapted horses dosed with NaHCO3, compared with other diet-treatment combinations (P = 0.0534; Table 1), and suggests a synergistic effect of fat-adaptation and induced metabolic alkalosis. There was no difference (P = 0.3190) in plasma PCO2 between NaHCO3 [52.43 ± 0.58 mmHg] and water treatments [51.81 ± 0.47]. Plasma PCO2 decreased at a greater rate (P = 0.0467) in fat-adapted horses compared with those fed the control diet and was 4.76 ± 1.63 mmHg below resting values at the end of exercise in fat-adapted horses compared with 0.88 ± 1.80 mmHg in horses fed the control diet. This difference in plasma PCO2 indicated an increased fatty

1 Presented as part of the Waltham Symposium on the Nutrition of Companion Animals in association with the 15th International Congress of Nutrition, at Adelaide, SA, Australia, on September 23–25, 1993. Guest editors for this symposium were Kay Earle, John Mercer and D’Ann Finley.

2 Supported in part by the John Lee Pratt Fellowship Program in Animal Nutrition, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, and the Waltham Centre for Equine Nutrition and Care, Verden, Germany.

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4 Abbreviations: [Lac−], lactate concentration; NaHCO3, sodium bicarbonate; PDH, pyruvate dehydrogenase.
BLOOD LACTATE CONCENTRATION DURING EXERCISE IN HORSES

TABLE 1

<table>
<thead>
<tr>
<th>Diet/treatment</th>
<th>Blood [Lac] mmol/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/water</td>
<td>5.73 ± 0.12</td>
</tr>
<tr>
<td>Control/NaHCO₃</td>
<td>6.26 ± 0.21</td>
</tr>
<tr>
<td>Fat/water</td>
<td>7.01 ± 0.20</td>
</tr>
<tr>
<td>Fat/NaHCO₃</td>
<td>9.47 ± 0.32</td>
</tr>
</tbody>
</table>

Values are means ± SEM, n = 4.
* Different from other diet/treatment combinations (P < 0.05).

[Lac] = lactate concentration; NaHCO₃ = sodium bicarbonate

An increase in blood [Lac] can be due to several factors, including increased production, increased efflux from cells and decreased clearance from blood. The increase in blood [Lac] observed in horses after NaHCO₃ administration was most likely due to an increased efflux of Lac from muscle cells (Spriet et al. 1986). A higher blood [Lac] in fat-adapted horses may be the result of several regulatory factors, including an inhibition of PDH caused by an increased oxidation of fatty acids (Jansson and Kaijser 1984, Randle et al. 1963).

LITERATURE CITED


