Iodine Balance in Relation to Iodine Intake in Ponies

Ulrich Wehr, Bettina Englschalk, Ellen Kienzle and Walther A. Rambeck

Institute for Animal Physiology, Physiological Chemistry and Animal Nutrition, Ludwig-Maximilians-University Munich, Munich, Germany

EXPANDED ABSTRACT

KEY WORDS: • iodine • ponies • iodine intake • iodine supply • iodine excretion

Iodine is an essential trace element for both, humans and animals because iodine is part of the thyroid hormones, which play an essential role in growth and development.

The horse has a high sensitivity for iodine: 3 to 5 μg iodine/kg body weight (BW) /d is recommended (1), based on the requirement of other species. The feed should contain 0.1 to 0.2 mg/kg dry matter (2). An overdosage of iodine often occurs because of the uncontrolled use of feed supplements in horse feeding practice. Even just an extra of 35 mg iodine per day (adult horses, dry matter intake: 10 kg) can cause severe health risks, leading to enlarged thyroids and lowered triiodothyronine (T3) and thyroxine (T4) values (3). Therefore a clinical indicator for the estimation of the equine iodine intake would be very useful. In humans and dogs (4), renal iodine excretion is used. The objective of this investigation was to find a similar practical indicator for horses. Thus, the following variables were measured: renal iodine excretion, fecal iodine excretion, protein-bound iodine in serum and serum concentrations of the thyroid hormones T3, T4, free triiodothyronine (FT3) and free thyroxine (FT4).

MATERIALS AND METHODS

Iodine balance trials with increasing supplementation of iodine (0, 20, 40 and 80 μg iodine/kg BW/d) were performed with four ponies (2 mares and 2 geldings). The ponies weighed from 230 to 360 kg, 4 to 11 yr of age. They were fed a hay/oats diet (iodine supply by the feed: 3 μg/kg BW/d). The feeding study lasted 70 d, with five feeding periods of 14 d each, including a pre- and a postperiod. The iodine supplementation was given orally as an aqueous solution (potassium iodate). Samples of blood and urine were taken every 7 d. At 6 h after feeding, blood samples were taken. After the same period urine samples were taken, as spot-urine in the geldings and by catheter in the mares. Feces were collected every 14 d over a time period of 24 h. The samples were analyzed for thyroid hormones (T3, T4, FT3, FT4 in serum), iodine content (serum, urine and feces), dry matter (feces) and creatinine (urine).

To determine the iodine content of the feed and feces a modified analytical method was used. This method is based on an alkaline ashing procedure followed by iodine determination using the Sandell–Kolthoff reaction (5). After precipitation of the protein-bound iodine, the same method was used to determine iodine in serum. The recovery rate was 95.4 ± 3.7 and 87.3 ± 4.7% (mean ± 1SD) for iodine analysis of urine and iodine analysis of feces and feed, respectively. The accuracy of our methods was assessed by neutron activation analysis (NAA).

For the determination of the urine samples, a WHO-recommended analytical method for the iodine analysis of human urine was used (6). The method, also based on the Sandell–Kolthoff reaction, was slightly modified to accommodate a wider range of iodine content, so it supplied reliable results for the iodine content of equine urine. Competitive luminous immunosorbent assays were utilized for determination of the thyroid hormones T3, T4, FT3 and FT4 in serum (Chiron, Fernwald, Germany). Urinary creatinine concentration was determined by a quantitative, colorimetric assay based on a modified Jaffe method utilizing alkaline picrate (Metra Biosystems, Mountain View, CA).

Statistical analysis

Results are expressed in mean values ± SD. Relationships between parameters are characterized by the coefficients of correlation (r). Significance was assumed for P < 0.05.

RESULTS AND DISCUSSION

In the present study we have compared serum variables (thyroid hormones, protein-bound iodine) and both renal and fecal iodine excretion as indicators of iodine intake in ponies. There were no significant effects of the increasing iodine intake in any of the thyroid hormones measured. All values of T3, T4, FT3 and FT4 were within normal ranges. The concentrations of the protein-bound iodine also did not change in relation to the iodine uptake. So the assessed

1 Presented as part of the Waltham International Symposium: Pet Nutrition Coming of Age held in Vancouver, Canada, August 6–7, 2001. This symposium and the publication of symposium proceedings were sponsored by the Waltham Centre for Pet Nutrition. Guest editors for this supplement were James G. Morris, University of California, Davis, Ivan H. Burger, consultant to Mars UK Limited, Carl L. Keen, University of California, Davis, and D’Ann Finley, University of California, Davis.

2 To whom correspondence should be addressed.

E-mail: rambeck@tiph.vetmed.uni-muenchen.de.

3 Abbreviations used: BW, body weight; FT3, free triiodothyronine; FT4, free thyroxine; NAA, neutron activation analysis; T3, triiodothyronine; T4, thyroxine; WHO, World Health Organization.
serum variables are not suitable to estimate the iodine intake over the range of iodine used in this study (Table 1). These variables could be of value if horses are exposed to toxic levels of iodine.

The majority of iodine was excreted via urine; the renal excretion was nearly equivalent to the iodine intake (Fig. 1). A significant correlation was found between the iodine intake and the renal excretion of iodine corrected for creatinine (r = 0.912; P < 0.001).

In contrast to dogs (4) and cats (7), in ponies the fecal iodine excretion increased slightly with higher intake. Fecal and renal endogenous losses calculated by regression analysis gave a value of about 7 g iodine/kg BW/d for these four ponies. This value is in a range similar to that of the dietary recommendations (2).

In conclusion, the renal excretion of iodine is considered to be a suitable variable for estimating the iodine intake of ponies under clinical conditions.

### LITERATURE CITED


### TABLE 1

<table>
<thead>
<tr>
<th></th>
<th>Preperiod</th>
<th>Period 1 + 20 µg I/kg BW/d</th>
<th>Period 2 + 40 µg I/kg BW/d</th>
<th>Period 3 + 80 µg I/kg BW/d</th>
<th>Postperiod</th>
</tr>
</thead>
<tbody>
<tr>
<td>T3, ng/dL</td>
<td>89.3 ± 2.2</td>
<td>84.6 ± 27.2</td>
<td>78.9 ± 29.2</td>
<td>81.2 ± 34.2</td>
<td>75.1 ± 26.2</td>
</tr>
<tr>
<td>T4, µg/dL</td>
<td>1.9 ± 0.4</td>
<td>1.5 ± 0.3</td>
<td>1.4 ± 0.4</td>
<td>1.5 ± 0.4</td>
<td>1.7 ± 0.4</td>
</tr>
<tr>
<td>FT3, µg/mL</td>
<td>3.4 ± 1.1</td>
<td>2.9 ± 0.8</td>
<td>2.9 ± 0.9</td>
<td>2.6 ± 0.9</td>
<td>2.4 ± 0.7</td>
</tr>
<tr>
<td>FT4, µg/dL</td>
<td>1.2 ± 0.4</td>
<td>1.1 ± 0.3</td>
<td>1.1 ± 0.2</td>
<td>0.9 ± 0.2</td>
<td>1.1 ± 0.4</td>
</tr>
<tr>
<td>Protein-bound iodine, µg/dL</td>
<td>2.5 ± 0.4</td>
<td>2.8 ± 0.7</td>
<td>2.9 ± 0.5</td>
<td>2.7 ± 0.7</td>
<td>2.4 ± 0.6</td>
</tr>
</tbody>
</table>

1 There were no significant differences in the investigated variables during the five periods.

![FIGURE 1](https://example.com/image1.png)  
**FIGURE 1** Iodine intake and iodine excretion in the feeding study. Iodine intake (in µg/kg BW/d) renal and fecal iodine excretion (means ± sd) of four ponies during five periods with increasing amounts of iodine and a postperiod without additional iodine supplementation.