Rumen pH and hoof health in two groups of captive wild ruminants

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Abstract

The connection between a feeding regime with a high proportion of concentrates and laminitis is well recognized in domestic animal medicine but has received little attention in captive wild hoofstock. We used the occasion of a transport of two ruminant groups, that necessitated immobilization, for an evaluation of the appearance of the hooves on the one, and of the pH of the rumen fluid gained by ruminocentesis on the other hand. A group of eight Himalayan tahr (Hemitragus jemlahicus) had a median rumen pH of 7.2 and a low hoof ring score, indicative of good hoof health. A group of seven blackbuck antelope (Antilope cervicapra), in contrast, had a median rumen pH of 6.0, and an intermediate hoof ring score and elevated hoof temperatures, indicative of a chronic laminitis. In relation to body weight, the feeding regime of the blackbuck included a higher proportion of concentrates. These observations suggest that a connection between concentrate feeding, low rumen pH, and hoof health could exist in captive wild ruminants, and that a feeding regime that prevents a drop of rumen pH could support hoof health.

Keywords
Laminitis, acidosis, feeding, zoo ruminant, hoof health

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Introduction

In domestic ruminants, the connection between rumen and claw health is well
established. The correlation of chronic rumen acidosis, due to a disproportio-
ately high concentrate intake, with laminitis and subsequent problems such as
claw abscesses, sole ulcers, white line disease, inadequate hoof growth or even
hoof overgrowth, is especially well-known in dairy cattle and receives particular
attention in the management of dairy herds (Nocek 1997; Ossent et al. 1997).
In the zoo literature, however, the interplay between diet and hoof health has
received comparatively little attention (Clauss and Kiefer 2003).

After a case of a roan antelope (Hippotragus niger) that was euthanized
after a history of a treatment-resistant lameness, and that was diagnosed with
chronic laminitis and a rumen pH at necropsy of 5.0 (Zenker, pers. obs.),
进一步 investigations into the occurrence of rumen acidosis and its potential
influence on the claw health of captive wild ruminants seemed useful. In the
course of a major translocation procedure of two groups of captive ruminants
at an Austrian zoo, a number of animals had to be immobilized. This occasion
was used to investigate the claw health of the animals and to assess rumen pH
by means of rumenocentesis (Nordlund and Garrett 1994) – a method that has
been propagated in dairy cattle (Strabel et al. 2007) yet is rarely used in zoo
animals.

Case report

Eight adult, apparently healthy Himalayan tahr (Hemitragus jemlahicus)
and seven blackbuck antelope (Antilope cervicapra) were translocated. Both
animal groups had been fed a diet of ad libitum grass hay, occasional browse,
and approximately 1 kg of fruits (apples, carrots) as well as 0.25–0.5 kg
commercial pellets (tahr: “Scha- und Ziegenfutter LS 4”, Bamberger, Uttendorf,
Prinzersdorf, Austria, 16.5 % crude protein, 9.3 % crude fiber; blackbuck:
“Pferdefutter P-6”, Bamberger, Prinzersdorf, Austria, 12.0 % crude protein,
8.3 % crude fiber) per group per day. Animals were group-fed.

Prior to immobilization, animals were observed by a veterinarian experienced
in lameness diagnosis for several minutes to assess whether any lameness was
evident (clinical score: 0 = no lameness or stiffness; 1 = slight lameness;
2 = moderate lameness; 3 = severe lameness, animal not able to walk and
recumbent). Animals were immobilized in the morning, without receiving
the usual morning feed ration. Immobilisation was performed by blowdart
using a combination of ketamin (100 mg/ml) and xylazine (125 mg/ml). Adult
tahrs were successfully immobilized with 0.7 ml of this mixture, subadults with
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0.4 ml. In blackbuck antelopes, 0.6 ml and 0.3 ml, respectively, were used. Animals were placed in right lateral recumbency.

Claws were evaluated by one, experienced investigator using a scoring system, originally developed for the evaluation of laminitis lesions in cattle (Greenough and Vermunt 1991). The system is based on the presence/absence of sole hemorrhages, waxy yellow horn and discoloration, presence of ridging on the dorsal wall of the claw, heat and increase in pulsation.

The sole was divided in six zones according to recommendations for cattle (Greenough and Vermunt 2002). Hemorrhages observed in each zone were scored on a three-point scale (1 = slight discoloration, 2 = moderate hemorrhage, 3 = severe hemorrhage). Temperature of the dorsal wall of the claws was also included into the scoring system (0 = temperature normal; 1 = moderate increase in heat; 2 = severe increase in heat). The occurrence of detectable pulsation in the digital arteries was also scored on a three-point scale (0 = pulsation not detectable; 1 = slight pulsation; 2 = moderate pulsation; 3 = severe pulsation). Deformation of the dorsal wall was evaluated similarly (0 = if not noticeable; 1 = slight ridges; 2 = grooves and a slight concave profile; 3 = severe grooves and concave profile).

After shearing, shaving and disinfection of a 2 cm² area caudoventral to the last rib, the rumen was punctured using a 1.2 × 50 mm needle, and rumen fluid was aspirated by syringe. Immediately afterwards, the pH of the rumen fluid was measured using a commercial paper-strip test kit (Merck Spezialindikator, pH 5.2–7.2, Merck KGaA, 64271 Darmstadt, Germany) based on a color reaction. Due to the limited sample size and the use of semi-quantitative measurements, no statistical testing of the data is presented here.

The results of the investigation are recorded in Table 2. A generally higher rumen pH was evident in tahr (median 7.2, range 6.2–7.5) as compared to blackbuck antelopes (6.1, 6.0–6.5). At the same time, blackbuck antelope scored higher in hoof ring and hoof temperature evaluation. There was no case of sole hemorrhage or lameness in tahr as opposed to two animals with sole hemorrhage and one animal with clinical lameness in blackbuck.

Discussion

Laminitis has a complex etiology and the significance of the various risk factors is discussed controversially. In domestic ruminants, subclinical and chronic laminitis are of paramount importance. Subclinical laminitis – by definition – produces no immediate clinical signs in cattle (Ossent et al. 1997). Horn quality deteriorates and hemorrhages occur with increasing frequency. In this study, there were no hemorrhages noted in tahr. Two blackbuck antelopes...
Table 1: Results of rumen fluid pH testing, hoof scoring, and presence of sole hemorrhage and clinical lameness in a group of Himalayan tahr and blackbuck antelope.

<table>
<thead>
<tr>
<th>Rumen fluid (pH)</th>
<th>Claw deformation score (0–3)</th>
<th>Claw temperature score (0–2)</th>
<th>Sole hemorrhage (1–3)</th>
<th>Lameness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tahr 7.2</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Tahr 7.2</td>
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<td>Tahr 6.2</td>
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<td>Tahr 6.4</td>
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<tr>
<td>Tahr 6.4</td>
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<td>Tahr 7.2</td>
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<td>Tahr 7.2</td>
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<tr>
<td>Median 7.2</td>
<td>1</td>
<td>0</td>
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<tr>
<td>Blackbuck 6.5</td>
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<td>Blackbuck 6.0</td>
<td>3</td>
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<td>Median 6.0</td>
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only showed slight hemorrhages and discoloration of the sole horn. Chronic laminitis is developing over a longer period and leads to characteristic claw deformation in affected cattle: the claws may have a flat shape with a fringe of frayed horn at the coronary band; alternate grooves and ridges at the dorsal wall lead to a washboard appearance. Horizontal grooves develop when the function of the epidermal stratum germinativum which produces the horn of the claw wall is compromised for a short period. The two blackbucks with sole hemorrhages were already suffering from chronic laminitis indicate which one in Table 1, one showing grooves and a slight concave profile, the other one with severe grooves and concave profile of the dorsal wall.

The case of these two ruminant groups showed that the scoring system for evaluation of claw lesions generally accepted in cattle (Greenough and Vermunt...
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1991) is only partly adaptable in wild ruminants. Due to pigment coating and quality of the horn in wild ruminants, the evaluation of slight hemorrhages and discoloration is more difficult than in cattle. The results indicate that a correlation of hoof health and rumen fluid pH in captive wild ruminants could possibly exist. However, the low sample size, the semi-quantitative nature of the data gained in this study, the fact that only two different species were investigated, as well as the fact that no reference data on rumen pH, hoof shape or hoof temperature exist for these species, do not allow any final conclusions. Nevertheless, this study indicates that similar studies, using a higher number of animals and a variety of species, a pH-meter instead of colour-based testkits, and a set of hoof evaluation scores, should be feasible. Whether ruminoentesis – which did not produce any negative effects in the animals of this study, as judged by regular observations during the weeks following the translocation, but which is discussed controversially in cattle practice (Strabel et al. 2007) – should be used for such an evaluation, or rather rumen fluid sampled by an oral probe, will depend on the experience and judgement of the responsible veterinarian.

A pH of 2.2 is usually considered diagnostic for subacute rumen acidosis (Nordlund et al. 1995). However, in more sophisticated studies with continuous pH monitoring in fistulated cattle, the time during which the pH is below 6.0 has also been shown to be an indicator for subacute rumen acidosis (Keunen et al. 2002). As continuous pH monitoring is not feasible in non-fistulated animals, a definite diagnosis may be difficult; the procedure used in this study – comparing the pH measured at comparable periods of the day between different animal groups – is a rational approach; in our case, the difference between the groups, rather than the absolute pH values themselves, should be regarded. If the nadir of ruminal pH shall be investigated, it is recommended to sample the animals 2–5 hours after the primary concentrate meal (Nordlund and Garrett 1994) – an approach that might not be recommendable in animal species that have to be immobilised for the procedure.

To date, few data have been generated to indicate a correlation of the dietary regime and the occurrence of hoof problems in zoo ruminants. In a questionnaire survey on captive giraffe (Giraffa camelopardalis), it was found that facilities that reported the occurrence of laminitis fed, on average, more fruits and vegetables, bread or grains to their animals than facilities that did not report any cases of laminitis (Hummel et al. 2006c). In dairy cattle, cases of rumen acidosis due to the feeding of fruits and vegetables alone have been reported (Slyter 1976), and in in vitro fermentation trials, the high acidotic potential of fruits and vegetables could be clearly demonstrated (Hummel et al. 2006a). Based on similar considerations, Baumgartner (2007) reported a dietary change in a group of Barbary sheep (Ammotragus lervia) that aimed at improving claw
health by reducing the proportion of concentrates in the diet. Both animal groups in our case report received approximately 1 kg of produce per day as well as 0.25–0.5 kg commercial pellets, which were low in fiber. The fact that both animal groups received similar quantities of these feeds in spite of an evident body size difference (body weight range blackbuck: 25–40 kg, tahr: 40–90 kg) indicates that it is probable that blackbuck ingested a higher proportion of these feeds. Due to the group-feeding situation, individual animals may have varied distinctively in the proportional concentrate intake. In evaluating herbivore diets for which no actual intake measurements are available, as in this case, it is reasonable to suspect that the palatable, concentrate portion of the diet is consumed completely and roughage is ingested to complement energetic needs (e.g. Flores-Miyamoto et al. 2005). If a higher intake of non-concentrate feeds is intended, therefore, it is not only necessary to offer highly palatable roughages, but also to reduce the amount of concentrate feeds offered (e.g. Liesegang and Wehrle 2006). Given these considerations, it appears likely that the blackbuck might have been predisposed, due to its diet, to subclinical, chronic rumen acidosis and subsequent hoof irregularities.

In cattle, there is experimental evidence that animals will adapt diet selection to attenuate subacute ruminal acidosis (Keunen et al. 2002). Nevertheless, acidosis is a frequent finding in domestic animals, especially under conditions of group feeding (Owens et al. 1998). Therefore, in feeding captive wild ruminants, acidotic feeds should be avoided in general, and any non-roughage portion of the diet should consist of a pelleted feed compound with high levels of fiber and low levels of sugars and starch (Oftedal et al. 1996); buffers may be added, and pectin-rich, less acidotic substrates such as beet pulp should be preferred as energy sources over grain or corn ingredients (Hummel et al. 2006b). If new ingredients are to be used, acidotic potential of these items can be assessed by in vitro measurements (Hummel et al. 2006a).

In domestic cattle husbandry, progress is being made with regards to optimal flooring in relation to hoof health (with a trend away from concrete towards softer surfaces) (Somers et al. 2003). Apart from such measures, a feeding regime that prevents rumen acidosis should be understood to be part of a prophylactic health management in order to prevent claw disorders, especially laminitis, in captive ruminants.

References

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