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Investigations on rumen and claw health of different wild ruminants related to subacute ruminal acidosis

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Summary

In this study four ruminant species of Nuremberg Zoo were evaluated for subacute ruminal acidosis according to the feeding management. Parameters of microbiological fermentation of the rumen as well as rumen tissue samples were examined. Additionally, investigations on claw health, in terms of laminitis were made. Three of the four species, all grass- and roughage feeders, showed severe characteristics of subacute ruminal acidosis due to a diet high in fermentable carbohydrates and low in fibre. One species, classified as intermediate feeder, appeared to tolerate the diet with this high concentrate rate, since no pathological variations were present. These results demonstrated that subacute ruminal acidosis is still a serious problem in captive wild ruminants, which are often fed wrong diets with a high concentration of easily digestible carbohydrates.

Introduction

The feeding of zoo and wild ruminants is of empirical nature, as it is based on data of feed intake and requirements recorded from domestic livestock. Captive wild ruminants do not have high production rates in contrast to livestock and do only need to cover their maintenance requirements (health, longevity, and in some cases for adequate reproduction) (COENEN and KAMPHUES 1995). Ruminants are specific high sophisticated herbivores, which can not be fed with uniform rations (HOFMANN 1995). Therefore ruminants are classified into a flexible system of three overlapping morphophysiological feeding types: concentrate selectors (cs), grass and roughage eaters (gr) and intermediate, opportunistic mixed feeders (im) (HOFMANN and STEWART 1972).

The most common disorders in captive wild ruminants are related to the gastrointestinal tract, due to inadequate feeding regimes. The most prominent example for those disorders is ruminal acidosis (HATT et al. 1995).

In the past few years several indications for subacute ruminal acidosis in certain ruminant species of Nuremberg Zoo were noticed: For example, deformed claws in the barbary sheep, although the claws were regularly trimmed, and poor body condition plus episodes of diarrhoea in the addax antelopes. The purpose of the present study was to investigate the rumen and claw health of certain ruminant species, relating to subacute ruminal acidosis. Associations with the feeding regime and diet compositions were made.

Materials and Methods

Five animals of four different ruminant species including blackbuck (*Antelope cervicapra*) barbary sheep (*Ammotragus lervia*), sika deer (*Cervus nippon dybowskii*) and addax antelope (*Addax nasomaculatus*) from Nuremberg Zoo were used in this study. All animals were killed for reasons according to ranking problems and overcrowding or in two cases in the blackbuck group due to an acute injury. The sample collection from these animals begun immediately after death and was completed within 30 minutes. Different samples were taken: Ruminal fluid for measuring the pH, lactic acid and short chain fatty acids (SCFA). Furthermore tissue samples of the ruminal atrium were taken. Histological investigations were performed to evaluate the various epithelial layers in rumen mucosa. To assess the status of claw health, claws were taken from the killed animals for macroscopical and microscopical investigations. In the study, the feedstuff of the four ruminant species were listed and weighed during 5 days. After analysing the single feedstuffs, the rations were calculated.

Results

The mean pH of rumen fluid was in a range between 6.3 and 6.6 and there was a significant difference between sika deer and Addax antelope (Fig. 1).

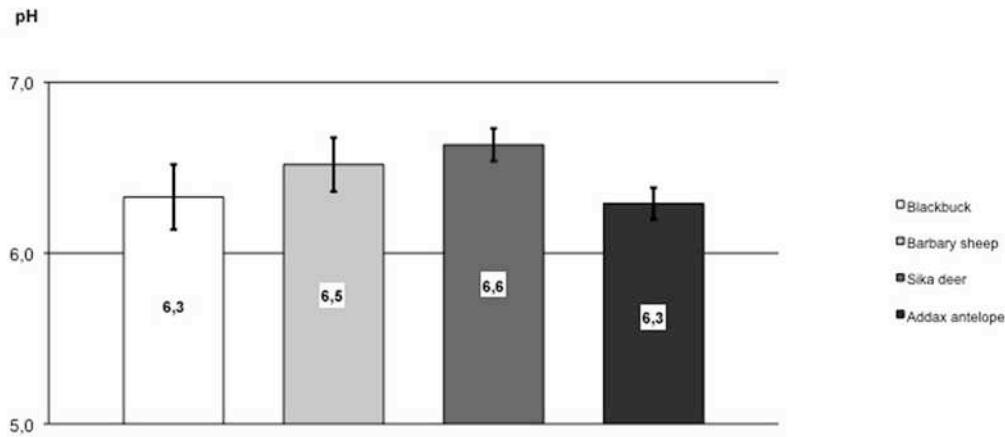


Fig. 1: Mean rumen pH \pm standard error

D- and L-lactate were not detectable in rumen fluid (detection limit: 0.3 mg/l). The SCFA-concentrations were in a physiological range of 50 mmol/l (sika deer), 71 mmol/l (blackbuck), 81 mmol/l (barbary sheep) and 80 mmol/l (addax antelope) (BERGMANN 1990). Also the molar proportions of the SCFA acetate, propionate and butyrate were in a physiological range (VAN HOVEN and BOOMKER 1985). Significant negative relationships were evident between SCFA and body weight and pH, respectively. The ruminal mucosa of all sika deer was without any pathological changes. Additionally, this species had the highest rumen pH and the lowest concentration of SCFA in the rumen. A multilayered epithelium, particularly the str. corneum with ballooned and low keratinised cells indicates active resorption due to a large food supply (Fig. 2A). In contrast, severe characteristics of ruminitis were present in the ruminal mucosa of blackbucks, barbary sheep and addax antelopes. There were numerous aggregations of leukocytes, named as micro abscesses, inside the ruminal mucosa in these species. Furthermore, the abnormal str. corneum consisted of several layers of flat epithelial cells containing high concentrations of keratin (Fig. 2B).

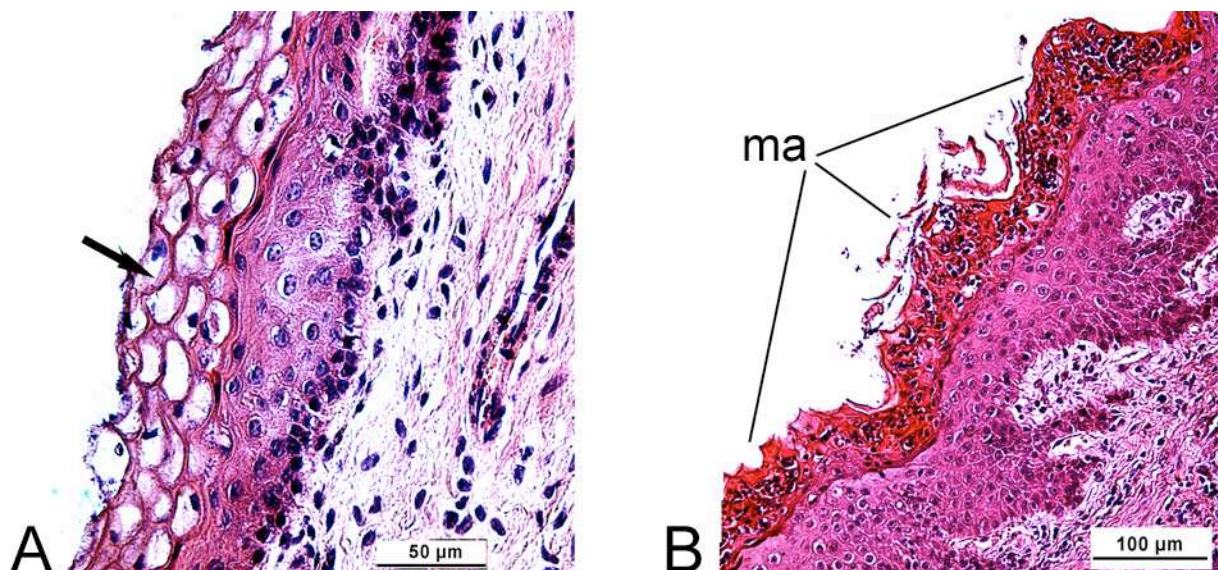


Fig. 2: A = Ruminal mucosa of a sika deer with ballooned and low keratinised epithelial cells
 B = Ruminal mucosa of a barbary sheep with numerous micro abscesses (ma)

Two of the five barbary sheep had macroscopical deformed claws. Microscopical investigations of the cross section of the lamellar layer revealed necrosis of the epidermal cells and haemorrhage, which can be interpreted as the first stadium of laminitis (Fig. 3).

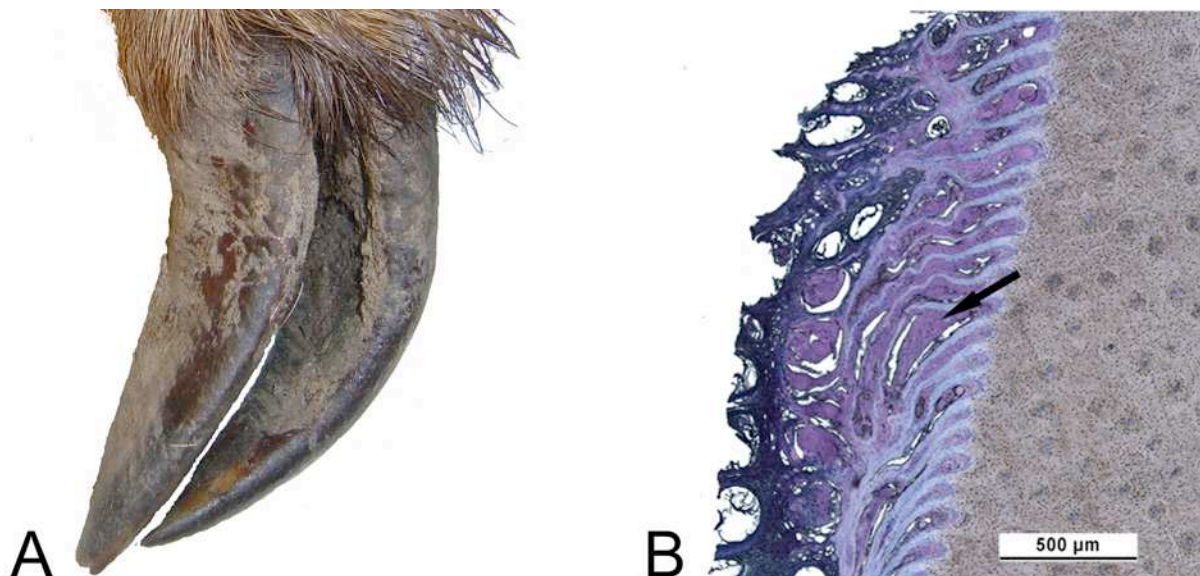


Fig. 3: A = Deformed back claw of a barbary sheep
 B = Cross section of the lamellar layer of the claw (A) with necrotic epidermal cells and haemorrhage

The diets of the four ruminant species consisted of roughage, concentrate feedstuffs and several vegetables and fruits. The diets were offered once a day. The evaluation of the feeding management and the following nutritional analysis were difficult to standardize, since a huge variability of the amount, particularly of concentrate feedstuffs, was evident between the different animal keepers. Mean values of summer- and winter-feeding were calculated. Following components for evaluating the ration were determined: crude fibre (blackbuck: 15%, barbary sheep: 18%, sika deer: 17%, addax antelope: 18%), NDF (blackbuck: 40%, barbary sheep 44%, sika deer: 41%, addax antelope: 44%), nfe (blackbuck: 57%, barbary sheep 55%, sika deer: 61%, addax antelope: 55%), crude protein (blackbuck: 17%, barbary sheep: 16%, sika deer: 12%, addax antelope: 16%). All values were based on dry matter basis.

Discussion

Subacute ruminal acidosis is defined as periods of moderately depressed ruminal pH, from about 5.5 – 5.0 and may be associated with laminitis (KRAUSE und OETZEL 2006). The parameters of rumen fluid (pH, SCFA, lactat) are closely related with the feeding. The sample collection in this study had to be done early in the morning before the animals were fed due to zoo management reasons (visitors of the zoo). For this reason, these values must be interpreted with caution (STEGER et al. 1970). This means, the pH is decreased after feeding of the concentrates which leads to lesions in the longterm. When samples are taken after a long period of “non-feed-intake” (the animals were only fed once in the morning), the pH is upregulated. This explains why the parameters which are usually changed during acute or subacute acidosis are not changed in the present study.

The severe lesions of the ruminal mucosa of the blackbucks, barbary sheep and addax antelopes, as well as the lesions of the claws of the barbary sheep, which are probably long term effects, are fundamental characteristics of subacute ruminal acidosis (KRAUSE and OETZEL 2006).

From these investigation under field conditions, it can be concluded, that in the blackbucks, barbary sheep and addax antelopes a temporarily altered state of the rumen (high pH after feeding) may lead to a subclinical acidosis caused by a high amount of concentrate feedstuff and weak structure. Additionally, the concentrates were offered only once daily which might influence the ruminal milieu in a negative way, since synchronicity was not guaranteed with this feeding regime (NORDLUND et al. 1995). In the group of sika deer there were no indications of subacute ruminal acidosis since there were no pathological changes in the ruminal mucosa nor in the claws. Furthermore in this species the rumen pH was highest (6.6) and the concentration of SCFA lowest (50 mmol/l). As the feeding regime and the diet composition were comparable to those of the other species, this may be a characteristic of this species (the sika deer) since they are classified as intermediate feeders. They are morphophysiologicaly intermediate and are characterised by remarkable anatomical adaptations to different forages (HOFMANN 1989). In this context sika deer of Zoo Nuremberg seemed to tolerate increased amounts of highly fermentable carbohydrates.

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