

# Topical treatment of multiple erosive, ulcerative skin lesions in an Indian rhinoceros (*Rhinoceros unicornis*)

## Topische Behandlung von multiplen erosiven, ulzerativen Hautläsionen bei einem Indischen Nashorn (*Rhinoceros unicornis*)

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### ZUSAMMENFASSUNG

Ein 30 Jahre altes, weibliches Indisches Nashorn (*Rhinoceros unicornis*) wurde aufgrund von seit 4 Jahren bestehenden erosiven, ulzerativen Hautläsionen vorgestellt. Die nicht juckenden Läsionen traten nicht saisonal auf. Eine systemische Antibiotikatherapie hatte zu keiner Besserung geführt. Die dermatologische Untersuchung zeigte 8 diffus abgegrenzte Bereiche mit Erosionen, fokalen Ulzerationen, leichter Krustenbildung und

mäßigen Erythemen mit einem Durchmesser von 8–20 cm bilateral an den seitlichen Rändern der Rumpfpfanzertplatten. Der Patient war ansonsten klinisch unauffällig. Zytologisch ließen sich Kokken und stäbchenförmige Bakterien identifizieren und in einer Bakterienkultur wurden *Escherichia coli* spp., *Staphylococcus dysgalacticae*, *Stenotrophomonas maltophilia*, *Corynebacterium* spp. und *Micrococcus* spp. nachgewiesen. Zur Behandlung diente eine topische Produktlinie mit essenziellen Fettsäuren und Pflanzenextrakten, die ein Spot-on-Präparat, ein Spray und einen Balsam umfasste. Innerhalb von 3 Wochen wurde eine wesentliche Besserung der klinischen Symptome beobachtet. Mehrfache Abklatschpräparate der Läsionen und eine erneute Bakterienkultur waren an Tag 21 negativ. Innerhalb von 4 Monaten nach der Behandlungsbeginn kam es zu einer vollständigen Remission, die bei fortgesetzter Anwendung der Therapeutika im Beobachtungszeitraum von 2 Jahren anhielt. Topisch anzuwendende Präparate, die essenzielle Fettsäuren und Pflanzenextrakte enthalten, können eine praktikable Behandlungsoption für wiederkehrende Fälle von bakteriellen Hautinfektionen bei Indischen Nashörnern darstellen.

### ABSTRACT

A 30-year-old, intact female Indian rhinoceros (*Rhinoceros unicornis*) was presented with ongoing erosive, ulcerative skin lesions over a 4-year-period. The lesions appeared to be non-pruritic and non-seasonal. A systemic antibiotic therapy had been unsuccessful. The dermatological examination showed 8 diffusely demarcated areas of erosion, focal ulceration, mild crusting, and moderate erythema ranging from 8 to 20 cm in diameter, bilaterally on the lateral edges of the torso armor plates. The patient had no other clinical abnormalities. Cocci and rod-shaped bacteria were identified on cytology and a bacterial culture revealed *Escherichia coli* spp., *Staphylococcus dysgalacticae*, *Stenotrophomonas maltophilia*, *Corynebacterium* spp. and *Micrococcus* spp. A topical product line containing essential fatty acids and plant extracts was administered daily, using a spot-on, spray and balm. Within 3 weeks a substantial alleviation of clinical signs was observed. Multiple impression smears of the lesions and a bacterial culture were negative by day 21. The patient achieved complete remission within 4 months of treatment and maintained remission for the 2-year observation period with continued use of the medication.

Topically administered therapeutics containing essential fatty acids and plant extracts may offer a viable treatment option

for recurrent cases of bacterial infectious skin lesions in Indian rhinocerotidae.

## Introduction

Only few reports of skin diseases in captive rhinoceroses exist [1][2][3][4]. Pyoderma is described as a condition associated with poor husbandry and stressful conditions, such as shipping [2]. The full aetiology as well as possible breed predilections and incidence remain unknown. Oral or intramuscular antibiotics are usually recommended for the treatment of bacterial pyoderma in rhinoceroses [2].

This case report describes an Indian rhinoceros with multifocal bacterial pyoderma on its lateral torso armour plates, which was successfully treated with a combination of 3 products containing essential fatty acids and plant extracts. To the best of the authors' knowledge, this is the first case report of successful topical treatments for recurrent erosive skin lesions in rhinocerotidae.

## Case description

### Patient and clinical presentation

An intact female 30-year-old Indian rhinoceros was presented with recurrent, waxing and waning, erosive to ulcerative skin lesions over a 4-year period, never in full remission. The animal had no clinical abnormalities apart from her skin condition. She was closely monitored by the zoo staff and appeared to be non-pruritic. The dermatological examination showed 8 skin lesions bilaterally on the lateral edges of the torso armour plates on the transition to the front legs on the level of the elbows (► **Fig. 1**). The affected sites were diffusely demarcated, moderately erosive with focal ulceration, and showed mild crusting with moderately erythematous underlying skin. The lesions were ranging from 8 to 20 cm in diameter, were non-seasonal and could not be correlated to any stressful event. On the contrary, a gestation and birth in 2013 did not lead to a deterioration but alleviation of skin signs. The condition had been unsuccessfully treated according to an antibiogram with trimethoprim (Sulfadimethoxin + Trimethoprim 50%, 417/83 mg/g, Medistar Arzneimittelvertrieb GmbH, Ascheberg, Germany [5]) for 21 days orally at a dosage of a 417/83 mg/g powder medication, which equals 65 mg/kg sulfadimethoxin and 14 mg/kg trimethoprim.

### Diagnostic approach, treatment and outcome

Cytology of multiple impression smears revealed coccoid and rod-shaped bacteria in equal proportions, a bacterial culture yielded *Staphylococcus dysgalacticae*, *Escherichia coli* spp., *Stenotrophomonas maltophilia*, *Corynebacterium* spp., and *Micrococcus* spp., sensitive to gentamicin, erythromycin, clindamycin, oxacillin, ampicillin, penicillin, amoxicillin plus clavulanic acid, trimethoprim-sulfonamides, enrofloxacin and florfenicol. As previous therapy with a trimethoprim-sulfonamide combination had failed to improve the animal's skin condition, the patient was treated exclusively with a spot-on, spray and balm formulation (all products from Laboratoire de Dermo-Cosmétique Animale, Technopôle Castres-Mazamet,

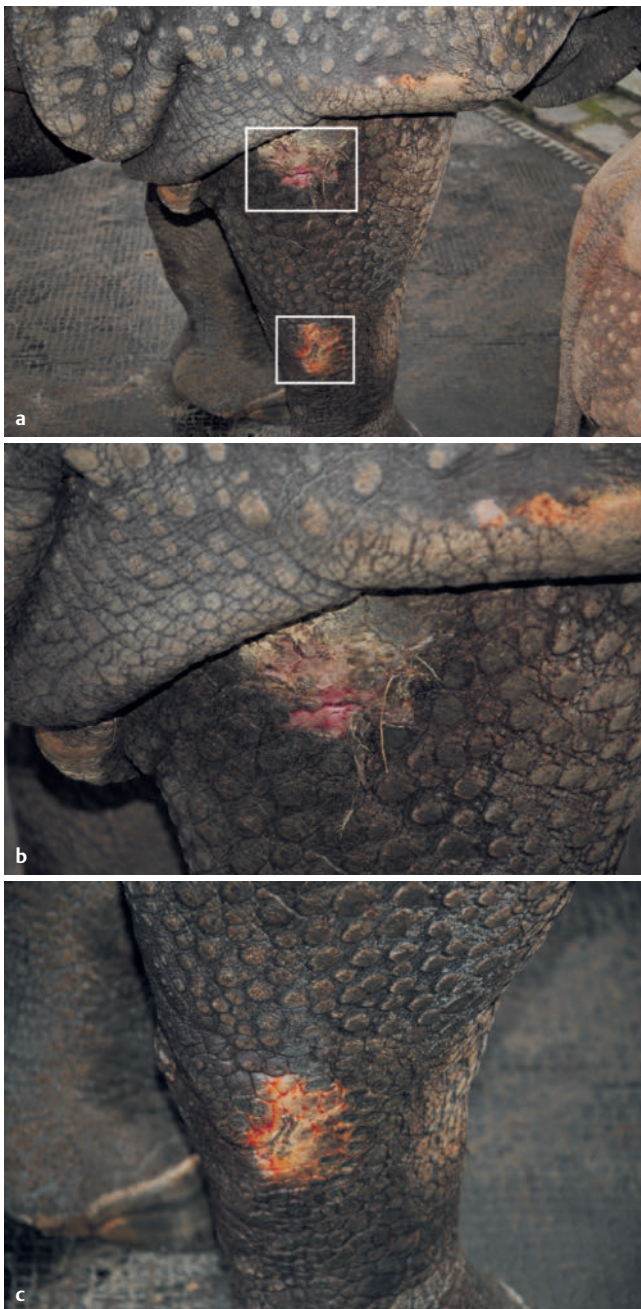
Castres, France) containing a variety of essential fatty acids and plant extracts [6]. The spot-on contained 2 plant extracts (ajowan and neem), combined with vegetable oils of tamanu and hemp, rich in  $\Omega$ -3 and  $\Omega$ -6 fatty acids and essential oils, such as lavandin, lemon eucalyptus, palmarosa and savory (Dermoscent Essential 6). The spray's ingredients were lavandin, manuka essential oils and N-acetylcysteine (Dermoscent Atop7). The balm contained cajuputoil and vegetable oil from soybean (Biobalm) [6]. For the duration of 4 months, the patient received the spot-on product twice weekly, one ampulla per lesional skin site, directly applied on the lesional skin. The spray and balm were both used twice daily, again directly applied on the lesional skin.

After 21 days, the skin lesions had substantially improved, and the erythema and crusting had decreased. At this time, multiple impression smears showed no signs of infection and a bacterial culture revealed minor growth (+) of *Streptococcus dysgalacticae*. After 4 months in total the rhinoceros was in complete clinical remission. The treatment was continued and the patient stayed in remission for the 2 years of follow-up. No signs of scarring at the site of the former lesions was observed after resolution of the skin condition.

## Discussion

Rhinoceros skin is composed of a relatively thin epidermis, about 1 mm thick with marked cornification [7]. The dermis on the other hand is markedly dense, inelastic, and shows large amounts of apocrine sweat glands in its superficial layer [2][7]. Superficial to deep, possibly infected skin lesions occur on many occasions, possibly because of their thin, sparsely haired epidermis, overlying the rigid dermis [8]. This layer reaches a thickness of 18–20 mm [7]. These anatomic features, especially the dense dermis, could explain the failure of systemic antibiotics in cases of rhinoceros pyoderma. A topical approach was therefore undertaken, in order to reach the bacteria directly.

Jarman et al. [4] hypothesised that the dermal thickness, forming dermal shields and moulding the skin's appearance is specifically adapted to the species' combat techniques. The skin is stronger around the areas of the back and flanks [9]. Other areas, such as the abdominal skin regions appear less strong, and more flexible [9]. This breed's skin can withstand stresses of 170 MPa and strains of 0.7 MPa [9]. These features are also the reason why no biopsies were obtained from the patient. The biopsies would have been very difficult to extract from the armour plates and the created wounds could have persisted, causing a deterioration of the skin condition. Furthermore, most likely a sedation or full anaesthesia would have been needed, which can be a certain risk for these exotic patients. The large body size of the rhinoceros species and their sensitivity to opioids complicates anaesthesia [10]. According to Portas [10] complications arise via hypoxaemia, hypertension, ventilation/perfusion mismatching, respiratory depression and pulmonary shunting.



► **Fig. 1** a Two lesions on the right front leg of the patient before treatment. b Close up of the proximal lesion. c Close up of the distal lesion. Source: © Tierpark Hellabrunn; R. S. Müller.

► **Abb. 1** a Zwei Läsionen am rechten Vorderbein des Patienten vor der Behandlung. b Nahaufnahme der proximalen Läsion. c Nahaufnahme der distalen Läsion. Quelle: © Tierpark Hellabrunn; R. S. Müller.

Indian rhinoceros skin is folded into deep grooves around the neck, shoulder and hips, which gives it an armour-like appearance [11]. The skin around these folds is hard and thick and their function still is unclear, even though it has been hypothesized, that its main function is insulation [11]. Hideki et al. [11] scanned the skin structure of Indian rhinocerotidae via computed tomography image analyses and microscopic examination. The subcutaneous

tissue of the creases contains cutaneous muscles and connective tissue, which lies up to 2–3 mm deep in each fold with marked vascularization [11]. Possibly, the folds could be important for thermoregulation, collecting heat from the core of the body to the surface of the folds [11]. Unfortunately, these creases can harbour moist and cause bacterial overgrowth leading to pyoderma.

For skin care and further thermoregulation, rhinocerotidae use mud wallows as a cleaning ritual with beneficial effect on a healthy and smooth skin [3]. The daily coverage of the skin's surface with a layer of mud serves as a cooling instrument and protects against insect bites [3]. Ahmad et al. [12] also report that the enrichment with mud wallows with firm and dense mud in the enclosures is crucial to the skin condition, declining with only water or watery mud wallows [12]. However, wallows can be a source of recurrent skin infection [1] and excessive wallowing in an unhygienic pond can lead to excessive flaking and hyperkeratosis of the skin and focal to multifocal skin infections with *Escherichia coli* [1]. The wallow accessible to our patient was cleaned several times with no effect but no bacterial cultures were taken. Possibly rainy weather conditions had led to a watery manifestation of the mud wallow contributing to the infection.

Silbermann et al. [2] report of 3 white, adult rhinoceroses with pustular dermatitis. One patient did not respond to the antibiotic treatment and died, one patient was treated for his *Pseudomonas* spp. infection with intramuscular gentamicin sulfate (4 mg/kg once daily for an unknown time period), and the other rhinoceros was treated for a *Staphylococcus* spp. infection with intramuscular ampicillin hydrochloride (20 mg/kg twice daily for 7–10 days) [2]. Silbermann et al. [2] further report 2 cases of recently imported, female, white rhinoceroses with severe exudative dermatitis. Their skin lesions were treated daily with 0.5% thiabendazole and 2.0% oxytetracycline over a 3-week period, which led to a granulation tissue formation and finally remission of the wounds [2]. Our patient had given birth to a calf in 2013 and the skin lesions improved during the time she took care of her calf. The authors hypothesize that the patient had less stress when the calf was born, due to distraction, and thus the skin condition showed improvement. On the other hand, anti-inflammatory hormones such as oestrogen [13], or oxytocin [14], could have led to a reduction of skin inflammation.

Husbandry and stress associated with life in captivity are hypothesized to be part of many conditions that rhinoceros do not develop in the wild [15]. Other than dermatopathies, rhinoceros can develop haemolytic anaemia and hepatopathy, which can lead to a higher morbidity and mortality [15]. The underlying reason for this remains unclear [15]. It is not known yet, if possibly dietary flaws could also enable skin lesions. In the Indian rhinoceros a too high amount of crude fibre can lead to laminitis [1], hypovitaminosis E in the black rhinoceros is suspected to cause haemolytic anaemia [15] and infertility in the white rhinoceros may be influenced by dietary phytoestrogens and a change in gut microbiota [16]. However, hypoaminoacidaemia was not present in black rhinoceroses with ulcerative skin lesions [17]. The environment and life style were already optimized as good as possible prior to treatment and thus fecal or urine samples were not obtained from this patient for cortisol measurement. Fecal cortisol levels can be measured by high-performance liquid chromatography in rhinoceroses in order to determine stress [18]. For instance Turner et al. [18]



monitored 5 black rhinoceroses after their release from translocation, where both fecal cortisol and corticosterone decreased significantly between week 1–6.

The healing process is classically slow, and can result in hyperplastic, thick wound margins, dense granulation tissue beds, mineralisation and even pseudocarcinomatous hyperplasia, visually resembling neoplasm-like structures [9]. In the black rhinoceros ulcerative lesions may be associated with decreased adrenal activity, however it remained unclear if the finding was a cause or effect of disease [18].

As a therapeutic approach 3 components were chosen, a spot-on, a spray and a balm product. A topical approach seemed reasonable because of the questionable efficacy of a systemic antibiotic reaching through the thick dermis. The clinical trial with systemic trimethoprim had already failed. Furthermore a topical approach is nowadays the preferred treatment option for focal, superficial bacterial infections [19]. Antiseptic shampoos, sprays, or even topical antibiotics if topical antiseptics do not heal the infection are still preferred over systemic antibiotics, in order to prevent resistance [19]. In wild life and zoo medicine a systemic approach is still often used as a first line treatment, due to compliance issues with the patients. However, with increasing medical training programs and a more cautious view on antibiotic usage due to rising bacterial resistances the topical options should be taken into consideration first.

The first component, the spot-on, contained plant extracts from ajowan and neem, vegetable oils of tamanu and hemp, and was rich in essential fatty acids ( $\Omega 3$  and  $\Omega 6$ ) and the essential oils lavandin, lemon oil, eucalyptus oil, palmarosa and savory oil [6]. The main active component was ajowan [20]. It has been successfully used for different medical conditions, such as neurological, respiratory or gastrointestinal disorders and is reported to have analgetic, anthelmintic and anti-inflammatory effects [20]. Neem has repelling and toxic effects against insects, through a complex called tetranortriterpenoid limonoid [21]. It is reported to have antifungal, antiviral, antibacterial, and immunostimulatory properties [22]. Hemp is rich in polyunsaturated fatty acids including linoleic acid,  $\gamma$ - and  $\alpha$ -linolenic acid [23][24]. Tamanu oil is reported to increase wound healing [25]. To the best of the authors' knowledge, there are no studies so far evaluating the penetration depth of these components into rhinoceros skin.

The second component of the product line, the spray, contained lavandin, manuka and N-acetylcysteine. Lavandin is known for neuronal depressive properties [26]. This could be responsible for a calming skin effect. The wound healing properties of medical grade manuka honey were the subject of numerous *in vitro* studies [27][28][29]. N-acetylcysteine was reported to have wound healing properties comparable to dexpanthenol [30].

The active ingredients of the balm, the third product, is cajuput oil [31]. Its antimicrobial properties are based on its capability to inhibit cell respiration and ion transport, alter membrane proteins and enhance cytoplasmic permeability, which eventually leads to the death of the microbe [32].

An autoimmune disease was also considered, however those diseases typically lead to gradually increasing clinical signs and would not be expected to improve with topical herbal substances. No case reports of pemphigus foliaceus, lupus erythematodes etc. in rhinoceroses have been published so far.

The long duration and initially treatment-resistant skin disease, the positive cytology and culture and the long-term remission with topical treatment are in favour of a chronic pyoderma responding to topical therapy. The underlying reason however remains unclear.

A biopsy of the skin lesions would have been crucial for detection of an underlying disease. However, it is generally extremely difficult to take biopsies of the armoured body parts due to their resistance and poor wound healing. One of the few areas of skin suitable would be a small area caudal of the ears, with relatively soft skin, but this area was normal. In addition, the risk of receiving a poor diagnostic result was high due to a lack of expertise in evaluating rhinoceros skin. Moreover, local anaesthesia is quite difficult to obtain in rhinoceros, due to the resistance of the skin, which makes subcutaneous injections (especially near the armoured plates) difficult. A full anaesthesia would have been necessary, which is complicated and dangerous for such large animals [10]. In order to find the underlying disease biopsies would have been of great value, however the bacterial pyoderma was already diagnosed by culture and cytology and stress-induced immunosuppression does not show pathognomonic changes on histopathology. Allergic skin disease had been ruled out by the clinical history of the patient. Thus, in the interest of animal welfare, we chose symptomatic topical therapy to avoid side effects in the long term.

To the best of the authors' knowledge, this is the first case report of a successful treatment of erosive skin lesions with essential fatty acids and plant extracts in a rhinoceros.

### CONCLUSION FOR PRACTICE

This case report describes a difficult to treat, recurrent bacterial infection with erosive and ulcerative lesion formation in an Indian rhinoceros. If conservative, topical and subsequently systemic antibiotic treatment options do not lead to a satisfactory alleviation of clinical signs, a topical approach with essential fatty acids and plant extracts may be curative.

### Conflict of interests

The authors were supplied with the topical products by Dermoscent® LCDA France. This company did not have any influence on the patient, medication, clinical evaluation or the manuscript.

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