Biochemical studies on the caprine hoof horn

Liviu C. BURTAN
Faculty of Veterinary Medicine Iasi, Alley M. Sadoveanu nr.8

Abstract
As the acropodial region is the segment through which the animal comes into contact with the ground, research was carried out on the biochemical composition of the caprine hoof horn. Samples were collected from the wall, interdigital cleft and sole of adult goats of similar age, kept under identical conditions. The studies aimed to determine the percentage of moisture and dry matter, as well as the presence of microelements such as Ca, Mg, Fe, Zn and Cu, which are involved in the process of keratinization. The obtained results highlighted the increased hygroscopicity of the non-pigmented horn compared to the pigmented one. An analysis of the different areas of the hoof horn showed that hygroscopicity is higher at the level of the sole (89.6% dry matter) in the pigmented horn, while in the non-pigmented horn hygroscopicity is higher at the level of the wall (80.6% dry matter). The biochemical examination confirmed the important role that the microelements play in the texture of the hoof horn, both in the case of pigmented and non-pigmented horn. Thus, the calcium expressed as mg / Kg varied between 0.059 in the non-pigmented sole and 0.052 in the interdigital cleft of the pigmented horn. Zinc came in second place, with variations between 0.14 mg / Kg in the pigmented wall and 0.04 mg / Kg in the non-pigmented wall. 0.084 mg / Kg of magnesium were found in the non-pigmented sole and 0.036 mg / Kg in the pigmented sole. Copper was identified mainly in the interdigital cleft (0.133 mg / Kg) and wall (0.027 mg / kg) of the pigmented horn. The studies that were carried out can serve as a guide to protecting the caprine hoof horn and stimulating keratogenesis in case of accidents that affect its integrity.
Keywords*: caprine, hoof horn, pigmented, non-pigmented, kerotogenesis.*

Introduction

The acropodial region, through its contact with the ground, represents an important segment in animal statics and dynamics (1,2,4). In goats, considered to be overly active animals, this region is prone to develop aseptic and septic traumatic disorders with severe progression (3,5,6,7). Due to this fact, the distal extremity of the acropodium, namely the two digits, is covered with a protective horny layer that is individualized for each digit and constitutes the hoof horn (2,6).

The hoof horn represents the hard part of the claw and consists of three distinct parts: the wall, which also includes the interdigital cleft, the sole and the heel. Due to its consistency, it provides protection against traumatic and infectious agents (3,5,7). The horn of the sole has a comma-like shape, being sharp towards the front and bulgy and thin at the level of the heels due to the development of the digital cushion bulbs. The wall of the hoof horn contains the periople, or the glossy layer of the claw, whose protection is ensured by the interdigital sinus secretion. The consistency of the wall is provided by the deep lamellar layer. The podophyllous laminae are more numerous in goats than in horses, their secretion generating a stronger horny layer (keraphyllous tissue), especially at the front of the hoof (2,6).

It is generally considered that hoof horn strength plays an essential role in the prevention and evolution of the diseases located in the acropodial region. This assertion is based on studies performed on the biochemical composition of the hoof horn in bulls (4) and pigs (1), which have highlighted the important part that microelements such as calcium, phosphorus, magnesium, sodium, copper, zinc and iron play in the keratinization process.

Material and Methods

Starting from the essential role that the hoof horn plays in the prevention and control of claw diseases, the research aimed to determine the mineral composition of the hoof horn and establish its elasticity and strength in the protection of living tissues. Finding out which are the main minerals that make up the texture of the hoof horn, establishing which areas are stronger and identifying which are the most important minerals involved in keratinization allows us to stimulate the growth of a more resistant horn and speed its repair process in case of accidents. The study also wanted to determine to what extent the pigmented horn of the claw is more resistant than the non-pigmented one.

In order to achieve the proposed objectives, hoof horn samples were collected from 8 goats by surgical detachment and tearing immediately after slaughter. Dirt was removed from the animals' claws with the help of a water jet before slaughter to ensure the cleanliness of the samples. To exclude the influence of age on the mineral composition of the hoof horn, the samples were collected from adult goats of similar age. The influence of the maintenance conditions was also excluded by collecting samples from goats that grazed on the same pasture for three months in a row and did not receive mineral supplements.

In order to establish the influence of pigmentation on horn resistance, pigmented hoof horns were collected from 4 goats, while non-pigmented ones were collected from the other 4. Mention must be made that all hoof horns came from the thoracic limbs.

Samples from the wall, interdigital cleft and sole were placed in crucibles, whose weight was known. The crucibles containing the samples were weighed again and then placed in the oven at 105 degrees C for 24 hours. When the desiccation process was complete, the crucibles were weighed once more. The difference between the weight of the crucible with the sample in it and its weight after desiccation represents the humidity percentage of the sample.

The biochemical composition of the hoof horn was determined with the help of a device called S A A-Pinacle T 700 - GFAAS (graphite furnace atomic absorption spectrophotometer) by using the ash resulting from the calcination and mineralization of the samples. In order to highlight the presence of the targeted minerals, LOD (limit of detection) and LOQ (limit of quantification) were taken into account.

Results and discussions

The research highlighted the importance of hoof horn texture in the statics and dynamics of the animal, considering its protective role. A hoof horn that is compact because of the minerals it contains, yet elastic due to the dry matter and moisture ratio, is an appropriate cover for the locomotion of this species. This assertion is supported by the data from the table below, in which protection is presented by contact areas, correlated with the pigmentation of the horn (Table 1.).

Table 1. Chemical composition of the caprine claw horn

Horn color	**Sample collection area**	**Chemical composition**						
		Dry Matter %	Water %	**Existing elements expressed as mg/kg**				
				Ca	P	Mg	Zn	Cu
Pigmented	**Sole**	85.6	14.4	0.054	0.060	0.036	0.13	0.013
	Wall	93.3	6.7	0.057	0.078	0.034	0.14	0.027

	Interdigital cleft	90.1	9.9	0.052	0.07	0.010	0.08	0.013
Non-pigmented	**Sole**	83.5	16.5	0.059	0.06	0.044	0.12	0.02
	Wall	80.6	19.4	0.056	0.071	0.010	0.04	0.025
	Interdigital cleft	87.9	12.1	0.058	0.062	0.012	0.13	0.015

Regardless of sample collection area, the pigmented horn contains a greater amount of dry matter than the non-pigmented one. This hardness can predispose to cracks in the hoof horn if the animal is overweight and moves on hard terrain. The elasticity of the hoof horn is higher in goats with depigmented horn due to the greater water content, and the galls of the sole horn caused by the friction with the hard terrain are less severe. Regardless of color, the interdigital sinus secretion covers both the interdigital cleft and the wall, providing them with the necessary protection against dehydration and consistency reduction.

As for the identified elements, they are found in greater quantity in the wall and, by the impregnation of the podophyllous laminae secretion, they contribute to the production of a consistent keraphyllous tissue. The structure of the podophyllous tissue also contributes to this consistency, as it contains more laminae than in other species.

Calcium is found in larger amounts in the wall (0.057 mg / kg) of the pigmented horn and in the sole (0.059 mg / kg) of the non-pigmented horn. The variations by areas of the hoof horn are insignificant, proving its role in the keratinization process. Phosphorus has an approximately uniform distribution, ranging from 0.06 mg / kg in the sole (regardless of pigmentation) to 0.078 m / kg in the wall of the pigmented horn. Magnesium varies between 0.010 mg / kg in the wall and 0.044 mg / kg in the sole of the non-pigmented horn.

Zinc variations range from 0.04 mg / kg in the wall of the non-pigmented horn to 0.14 mg / kg in the wall of the pigmented horn. Copper values vary between 0.013 mg / kg in the interdigital cleft and sole of the pigmented horn and 0.027 mg / kg in the same type of horn, the depigmented horn having intermediate values.

The analysis of the values presented leads to the idea of correlating the biochemical values of the hoof horn with those of fodder and feed supplements. It offers us the opportunity to think about how we can improve the structure and resistance of the hoof horn by means of controlled feeding, correlated with the structure of soil and fodder. We consider this correlation to be more beneficial than therapeutic intervention in case of hoof horn degradation and septic complications.

Conclusions

1. The biochemical studies showed structural differences between the pigmented and non-pigmented hoof horns coming from goats that were kept under the same conditions.
2. The wall of the pigmented hoof horn is stronger (93.3% dry matter) than the one of the non-pigmented horn (80.6% dry matter).
3. The microelements involved in the texture of the hoof horn, namely in the process of keratogenesis, were calcium, phosphorus, magnesium, zinc and copper. The values,

determined from the dry matter and expressed as mg / kg, varied depending on the chemical element and the sample collection area.

Bibliography

1. Burtan I. – Contribuții la studiul și profilaxia afecțiunilor aparatului locomotor la porcine în sistemulde creștere intensivă. Teză de doctorat,Institutul Agronomic Iași, 1978.
2. Coțofan V., Predoi G. – Anatomia topografică a animalelor domestice. Editura BIC ALL,Timișoara, 2003.
3. Moga Mânzat R., Moldovan M.,Vintilă Cornelia – Pododermatitele infecțioase ale rumegătoarelor. Ed.Ceres, București 1984.
4. Moroșanu N. – Contribuții la studiul și tratamentul afecțiunilor podale la bovine. Teză de doctorat. I.A.N.B. București, 1969.
5. Perianu T. – Bolile infecțioase ale animalelor. Bacterioze,vol.I.,Ed.Iași p.302-310.
6. Velescu Elena – Cercetări privind pododermatita infecțioasă la ovine. Teză de doctorat, Univ.Agr.și Med.Vet. Iași,1997.