

Clinico-pathological findings in natural cases of “mascadera” in goats

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Abstract “Mascadera” is a chronic emaciating neuropathy affecting goats; it produces significant economic losses in many regions and its cause is unknown. Here, the histological lesions found in 15 animals naturally affected by the disease are described. Complete necropsy was performed and tissue samples were collected for histopathological study. Severe atrophy of the masseter and buccinator muscles and tongue was observed, as well as vacuolar degeneration of neurons in the nuclei of the trigeminal, facial, and glossopharyngeal nerves. No relevant lesions were observed in other tissues. These findings and the clinical signs are consistent with those observed by other authors in animals spontaneously and experimentally intoxicated with *Prosopis juliflora*. The disease may be due to consumption of a similar species present in our country that is still unknown. Further research on the etiology and pathogenesis of this disease is needed to establish appropriate prevention guidelines.

Keywords Poisoning · Neuropathic muscular atrophy · *Prosopis* spp.

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Goat rearing is one of the production alternatives in arid and semiarid regions and marginal zones (Silau and Ploszaj 2009). In Argentina, the goat population is estimated in 3,964,146 and provides economic support for 50,000 small-scale producers of low sociocultural level (SAGPyA 2005). Reproductive and sanitary problems affecting goats are a serious limiting factor to production efficiency (Nogués et al. 1994). Among the diseases most frequently reported for this productive sector is the “caprine mascadera” (Bedotti and Rossanigo 2011). This disease is a chronic disorder of unknown origin, affecting goat flocks from Jujuy, Salta, La Rioja, Catamarca, Córdoba, San Luis, Neuquén, La Pampa, and Rio Negro provinces (Rossanigo et al. 2003). These provinces concentrate a great proportion of the goat stock in Argentina (Silau and Ploszaj 2009). Affected animals have chewing difficulties, showing severe weight loss, emaciation, and finally die within a variable period (Rossanigo et al. 2003). Despite all of the above, there are no studies that investigate the pathophysiology of the disease. This paper describes the clinical and pathological findings observed in goats naturally affected by this disease.

Complete necropsies of 15 animals affected by the disease were performed. Twelve animals were from goat flocks from La Rioja province and three were from Salta province. All of the flocks had a history of goat “mascadera”. Both regions are characterized by an arid or semi-arid climate with a low rainfall rate (200–400 mm annually) concentrated during the summer with a long dry winter season (Bianchi and Cravero 2010). Extensive caprine production is one of the main economic activities in these two regions (De Gea Ginés et al. 2005). All individuals were females, except for an adult male, and most animals were adults of medium to advanced age. Farms were exploited extensively and goats fed mainly on natural pastures and fruits from woodland trees. Samples were collected in 10% buffered formalin, processed using classical

histological techniques of paraffin inclusion, and stained with hematoxylin and eosin (Kiernan 2015).

The affected goats presented different degrees of disease. Five of the necropsied individuals exhibited mild mandibular tremor and, according to the farmers, they had shown the signs after having been subjected to feeding changes. Eight animals showed awkward mastication; when these movements ceased, the goats showed continuous or intermittent mandibular tremors. Four of these animals showed evidence of rumen fluid falling through the lipsticks' corners, as observed in the greenish appearance of the labial commissure and chin (Fig. 1a). Two animals exhibited total paralysis of the lower jaw, which was evident in their inability to close the mouth; one of them had part of the bolus accumulated in vestibule of the labial commissure. Moreover, the loss of ruminal fluid through the labial commissures and a greenish coloration of the lips were observed during rumination, which is evident in the presence of small stain on the ground where animals lie (Rossanigo et al. 2003). The clinical findings were the same as those described by a similar disease named "coquera", which was described in Peru; it was artificially induced in goat by administering pods of *Prosopis juliflora* (Bacca et al. 1963). In Brazil, cases of poisoning due to the consumption of same plant were reported in goats (Lima et al. 2004) and cattle (Câmara et al. 2009).

In the necropsies, all these animals exhibited a general poor condition: serous atrophy of omental, perirenal, and pericardial fat. Variable degrees of atrophy of masticatory and extrinsic lingual muscles were observed, although these lesions were not easily perceivable (Fig. 1b). In some animals, transverse section of masseter showed whitish striations in the lingual extrinsic muscles. In goats from Salta, a high proportion of seeds of *Prosopis* spp. was found in the rumen content. In the same line, histological findings of the samples of buccinator, masseter, and extrinsic tongue muscles, 100% (15/15), exhibited degenerative changes, with cytoplasmic hyper eosinophilia, loss of striations, and fragmentation of muscle fibers (Fig. 2b). Some muscle fascicles presented severe degeneration. Even in terminal cases, the muscle tissue was replaced with abundant connective tissue and hyaline floccules. All cases exhibited

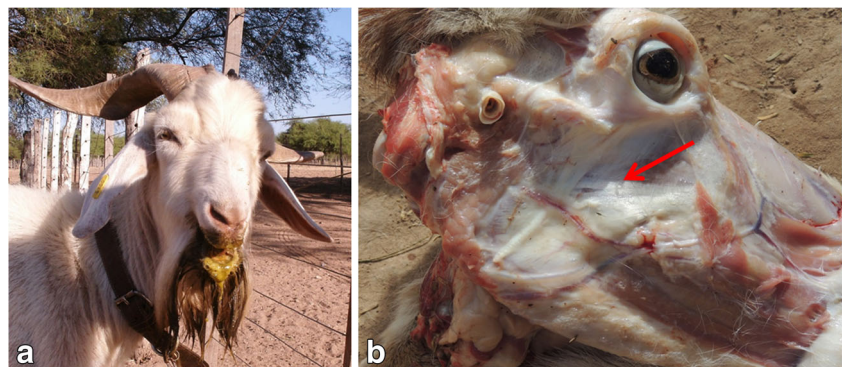
focal or diffuse mononuclear infiltration of variable degree. Hyperplasia of lingual salivary glands and buccinator muscle was observed in 33.3% of the samples (5/15).

Neuropathic muscular atrophy has been reported as one of the most frequent causes of muscular atrophy in domestic animals (Van Vleet and Valentine 2007; Valberg 2010). Maintenance of muscle fibers requires a low neural tonic stimulus; when this stimulus is absent, fibers retract and can undergo degeneration and pyknosis (Valberg 2010). The processed brain samples showed focal gliosis with diffuse vacuolation and swelling of some neural bodies in the trigeminal (15/15), facial (8/15), and hypoglossal (10/15) motor nuclei (Fig. 2a). Degeneration, vacuolation of neurons, and gliosis observed in this nerve nuclei indicate that atrophy of lingual and masseter muscles are due to innervation disorders. Nerve lesions were identified in 100% of the cases, but not in all the nerve nuclei. In *Prosopis juliflora* poisoning, the lesions described are severe muscular degeneration and atrophy of masseter and lingual muscles (Bacca et al. 1963; Câmara et al. 2009), as well as swelling and diffuse vacuolation of neurons of hypoglossal and trigeminal nerves (Tabosa et al. 2000). All these findings are consistent with our results. All pathological findings indicated severe degeneration and atrophy of masseter and lingual muscles, which explains the disorders in chewing and swallowing observed in the affected goats.

Silva et al. (2007) indicated that the alkaloids from *P. juliflora* act directly on glial cells, inducing activation and/or cytotoxicity, stimulating NO production, and may have an impact on neuronal damages observed on intoxicated animals.

It has been hypothesized that goat mascadera is the result of a reticulum-rumen indigestion caused by consumption of food of low ruminal degradability, which generates ruminal stasis, i.e., absorption of toxic substances that are usually degraded or not synthesized in the healthy organism (Rossanigo et al. 1994; Rossanigo et al. 2003). However, the possibility of chronic poisoning due to consumption of plants of the genus *Prosopis* cannot be discarded, given the observed similarity of clinical signs and histopathological lesions to those reported for *Prosopis juliflora* poisoning (Tabosa et al. 2006). Moreover, the abundance of species of this genus is well known in the regions where

Fig. 1 **a** Goat affected by mascadera, showing greenish coloration in the labial commissures due to loss of ruminal fluid. **b** Severe atrophy of the masseter muscle characterized by tissue depression in the projection area of mentioned muscle (arrow)



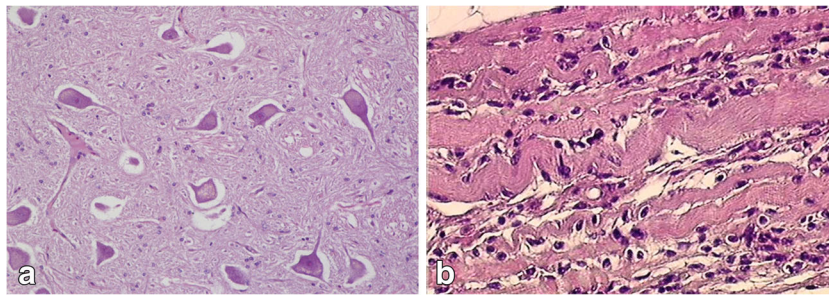


Fig. 2 Microscopic image. **a** Vacuolation and degenerative changes in neurons of the trigeminal nucleus (H & E- 4 X). **b** Muscular fibers of masseter muscles, showing degeneration and fragmentation of muscular

fibers. Abundant mononuclear infiltration is also observed between fibers (H & E- 10 X)

the disease occurred. *Prosopis* spp. are mostly phreatophytes, colonizers, or invaders that resist salinity, alkalinity, and cold climate (Roig 1993, William and Jafri 2015). One hectare with some 100 adult plants of *Prosopis flexuosa* is expected to produce between 400 and 500 kg of fruits in one season, which is a valuable food resource for livestock and regional populations (Dalmaso and Anconetani 1993). The great number of pods that should be consumed and the time required for experimentally reproducing the disease are consistent with the great variability in morbi-mortality observed among regions and years. Mean morbidity rate reported in affected herds is 8.8% (range: 34–0.5%) and a mortality rate of 87.3% (range: 100–25%) (Rossanigo et al. 2003). The disease has also been described in cattle and was experimentally induced using diets containing 50–70% of *P. juliflora* pods during 45–75 days (Tabosa et al. 2006). Goats seem to be more resistant, requiring 60–90% of pods in the diet during approximately 210 days to present clinical signs (Tabosa et al. 2000, 2004). Sheep appear to be even more resistant, since they did not undergo poisoning after receiving diets with 70–100% pod content for 1 year (Lima et al. 2004). However, a recent report from Brazil, mentioned natural poisoning in lambs by *P. juliflora* (Almeida et al. 2017).

Finally, further studies are necessary to increase the knowledge about goat mascadera, since it produces great annual losses in goat flocks from a large region in Argentina. Information about its etiopathogenesis and other associated factors is crucial for taking suitable preventive measures. The phytochemical study, once identified the suspect species, would allow a substantial approximation to the diagnosis.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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