

1 **Case Report**

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3 **Gastritis in a llama (*Lama glama*) caused by spontaneous *Baccharis coridifolia* DC.**
4 **(“mio-mio”) poisoning in the Santa Catarina Plateau, Brazil**

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21
22 **Abstract**

23 This report describes the first known spontaneous case of *B. coridifolia* poisoning in a
24 domesticated llama. In August 2023, the death of a 10-month-old female llama was reported on
25 a farm in the Santa Catarina Plateau, Brazil. The affected llama had been acquired 2 months

26 earlier from Paraná and initially kept with sheep on ryegrass pasture. One day before death, it
27 was moved to a native field heavily invaded with *B. coridifolia*. Clinical signs included
28 polydipsia and muscle tremors, progressing rapidly to death approximately 14 h after the onset
29 of clinical signs. At necropsy, the 1st and 2nd gastric compartments (C1 and C2) contained
30 abundant fibrous ingesta and exhibited mild mucosal congestion. In the 3rd gastric compartment
31 (C3), mild to moderate congestion, predominantly affecting the caudal region, was observed.
32 Histopathology revealed marked diffuse mucosal necrosis with inflammatory infiltrates
33 predominantly composed of neutrophils and macrophages, and mild edema in the aglandular
34 portions of C1 and C2. In C3, mild to moderate congestion was observed. Additional findings
35 included pulmonary congestion and edema, renal congestion, and centrilobular hepatocellular
36 degeneration. Specimens of *B. coridifolia* collected from the property were submitted to the
37 Herbarium Lages of the State University of Santa Catarina (LUSC) for botanical confirmation.
38 The epidemiological, clinical, and pathological findings supported the diagnosis of *B.*
39 *coridifolia* (mio-mio) toxicosis. This case underscores the importance of proper pasture
40 management and careful monitoring when relocating animals to areas containing known toxic
41 plants.

42

43 **Keywords:** mio-mio, herbivores, South American camelids, toxic plants, third gastric
44 compartment.

45

46 **Introduction**

47

48 The llama (*Lama glama*) is one of 4 native South American camelids, along with the
49 alpaca (*Vicugna pacos*), guanaco (*Lama guanicoe*), and vicuña (*Vicugna vicugna*) (20).
50 Historically domesticated, llamas and alpacas play a significant role in the Andean economy

51 due to their production of wool, meat, and artisanal goods (12). Geographically, llamas are most
52 prevalent in Bolivia, Peru, Chile, and Argentina, with increasing captive breeding in Brazil for
53 exhibitions, zoos, and animal production purposes (15, 17).

54 Physiologically, digestion in camelids is similar to that of ruminants, including
55 regurgitation. However, they differ anatomically by possessing 3 gastric compartments with
56 glandular regions and lacking papillae (12).

57 *Baccharis coridifolia* DC., commonly known as “mio-mio,” is widely distributed in
58 pastures across Argentina, Uruguay, Paraguay, and Brazil - particularly in the states of Rio
59 Grande do Sul, Santa Catarina, Paraná, and São Paulo. It is the main plant associated with
60 poisoning cases in southern Brazil, causing gastrointestinal lesions in several domestic species
61 (5, 23).

62 Spontaneous *B. coridifolia* poisoning has been described in cattle, sheep (19), buffaloes
63 (9), and horses (1). Such cases typically occur when animals originating from areas free of the
64 plant are introduced into infested pastures, or when high-quality forage is scarce (19). To the
65 authors’ knowledge, spontaneous *B. coridifolia* poisoning has not previously been reported in
66 llamas or other South American camelids. Therefore, this report aims to describe the
67 epidemiological, clinical, and pathological findings of spontaneous *B. coridifolia* poisoning in
68 a llama in the plateau region of Santa Catarina, Brazil.

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70 **Case description**

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72 In August 2023, a 10-month-old female llama (*L. glama*) died on a property located in
73 São José do Cerrito, in the plateau region of Santa Catarina, Brazil.

74 The animal had been acquired, along with a male of the same species, approximately 2
75 months earlier. Both llamas originated from Saudade de Iguaçú, Paraná, and were kept with a

76 flock of sheep, sharing the same paddock with ryegrass pasture. However, detailed information
77 regarding their management conditions prior to acquisition, including feeding practices and
78 possible previous exposure to *B. coridifolia*, was unavailable. On the day prior to death, the
79 llamas were moved to a native grassland area, where they remained during the day. That
80 evening, upon being gathered, the affected animal exhibited polydipsia. The following morning,
81 it was found in a state of agony, presenting muscle tremors that progressed to death. The average
82 time from onset of clinical signs to death was approximately 14 h. According to the owner, the
83 property had a history of spontaneous *B. coridifolia* poisoning in sheep in previous years,
84 confirmed by necropsy and histopathological examination. The affected sheep were born in
85 areas free of the plant and later transferred to native pasture invaded by *B. coridifolia*.

86 The llama was sent to the Animal Pathology Laboratory of the State University of Santa
87 Catarina (Udesc) for necropsy and subsequent histopathological evaluation using hematoxylin
88 and eosin (HE) staining.

89 At necropsy, the animal had a moderate body condition score and showed accumulation
90 of dry feces around the anus. The 1st and 2nd gastric compartments (C1 and C2) contained a
91 large amount of ingesta, predominantly composed of plant fiber, and multifocal areas of
92 superficial epithelial detachment associated with mild congestion were observed in the mucosa
93 of these compartments. However, the gastric contents were not submitted for botanical
94 identification. In the 3rd compartment (C3), mild to moderate congestion was observed,
95 predominantly affecting the caudal region. (Fig.1A). The gastric pH was 6.5. Additionally, the
96 lungs and kidneys were diffusely reddened, and the liver exhibited a mildly prominent lobular
97 pattern.

98 Histologically, the aglandular portions of the 1st and 2nd gastric compartments showed
99 marked diffuse mucosal necrosis associated with marked diffuse inflammatory infiltrate
100 predominantly composed of neutrophils and macrophages, and mild edema within the lamina

101 propria (Fig. 1B). In the 3rd compartment, mild to moderate congestion was observed. The lungs
102 presented moderate congestion and edema, the kidneys moderate congestion, and the liver
103 moderate multifocal to coalescing hepatocellular degeneration, predominantly in the
104 centrilobular region.

105 A population of plants identified as *B. coridifolia* was observed in the native grassland
106 area where the animal had been kept (Fig. 2). A site visit was conducted, and specimens of the
107 plant were collected and sent to the LUSC Herbarium at the Center for Agricultural and
108 Veterinary Sciences (CAV)/Udesc for botanical identification and species confirmation. The
109 specimen (Wisser, C. S., no. 2), collected on April 30, 2024, was registered in the herbarium
110 under catalog number LUSC 11950 and barcode 011685.

111

112 **Discussion**

113

114 *B. coridifolia* poisoning typically follows an acute clinical course in herbivores,
115 although the progression may vary among species (1, 14, 16, 22). In the present case, the
116 affected llama developed clinical signs shortly after introduction into a pasture invaded by the
117 plant and died approximately 14 h after the onset of clinical signs, consistent with the clinical
118 course previously described in naturally affected herbivores. Although detailed information
119 regarding previous management before acquisition was unavailable, the rapid onset and
120 progression of clinical signs after exposure supports the epidemiological diagnosis of acute *B.*
121 *coridifolia* poisoning.

122 The main clinical signs observed included polydipsia and muscle tremors, in addition to
123 dry feces around the anus, similar to findings described in cattle (14). The increased water intake
124 seen in this case is frequently reported in more severe intoxications and can lead to the
125 erroneous assumption that hydration worsens the toxicosis. However, it is now understood that

126 polydipsia is a physiological response to poisoning rather than a factor contributing to the fatal
127 outcome (22).

128 The necropsy findings observed in the present case are consistent with those previously
129 described in herbivores affected by *B. coridifolia* poisoning, including sheep, cattle, and horses,
130 in which congestion, edema, erosions, and necrosis affecting different gastric compartments are
131 commonly reported (1, 14, 16). In some cases, mesenteric lymph nodes may appear enlarged
132 and edematous (16), which was not observed in the present case.

133 Histopathological lesions in *B. coridifolia* poisoning exhibit a relatively consistent
134 pattern among affected species, characterized by degeneration and necrosis of the
135 gastrointestinal epithelium, mucosal and/or submucosal edema, inflammatory infiltrates
136 composed of mononuclear and polymorphonuclear cells, and variable degrees of congestion
137 and hemorrhage throughout the stomach compartments. However, the distribution of lesions
138 within the digestive tract may vary according to the species affected. In sheep and cattle, lesions
139 are predominantly observed in the rumen and reticulum, whereas in horses all gastric regions
140 may be similarly affected (1, 14, 16). The histological findings observed in the present case are
141 consistent with this pathological pattern and support the toxic effects of macrocyclic
142 trichothecenes produced by fungi associated with *B. coridifolia*, which are known to induce
143 epithelial necrosis and severe gastrointestinal injury (11). Variations in lesion severity may be
144 influenced by factors such as ingested dose, duration of exposure, species-specific physiology,
145 and individual susceptibility.

146 Secondary systemic lesions affecting the lungs, kidneys, and liver have also been
147 reported in herbivores affected by *B. coridifolia* poisoning and are likely associated with acute
148 toxemia, circulatory disturbances, and vascular injury induced by macrocyclic trichothecenes
149 (22, 11). The centrilobular hepatic degeneration observed in the present case may reflect

150 hepatocellular injury associated with hypoxia and systemic toxic effects during the acute
151 clinical course (22).

152 Like other members of the Camelidae family, llamas are classified as pseudoruminants
153 because they possess 3 gastric compartments functionally analogous to the forestomachs and
154 abomasum of true ruminants (7). These anatomical and physiological similarities may explain
155 the comparable distribution and pattern of gastrointestinal lesions observed in llamas, sheep,
156 and cattle following *B. coridifolia* poisoning. Despite not being true ruminants, llamas appear
157 susceptible to the toxic effects associated with macrocyclic trichothecenes produced by fungi
158 linked to the plant.

159 For an accurate diagnosis of *B. coridifolia* (mio-mio) poisoning, epidemiological
160 findings, clinical progression, and anatomopathological lesions must be interpreted together
161 (21). Differential diagnoses should include other toxic plants capable of inducing acute
162 gastrointestinal lesions in herbivores. In southern Brazil, important plant-related differentials
163 include *Baccharis megapotamica* var. *megapotamica* and var. *weirii*, *Baccharis vulneraria*
164 Backer, and *Raulinoreitzia tremula*, all of which can induce clinical and pathological findings
165 similar to those caused by *B. coridifolia* (4, 10, 22). In the present case, the epidemiological
166 investigation and botanical identification of the plant present in the pasture, combined with the
167 absence of other toxic plant species associated with similar lesions, supported the exclusion of
168 these differential diagnoses.

169 Other toxic and metabolic conditions should also be considered in animals presenting
170 with acute gastrointestinal lesions. Ruminal acidosis may affect the 1st stomach compartment
171 of llamas and is typically associated with markedly reduced gastric pH (4.5-5.0) and excessive
172 intake of concentrate feed (3), which were not observed in the present case. Sodium
173 fluorosilicate poisoning may also cause gastrointestinal hyperemia, hemorrhage, and necrosis
174 following environmental contamination of pastures or water sources by fluoride-containing

175 residues (13). Acute lead arsenate poisoning should likewise be considered because it can
176 produce necro-hemorrhagic and ulcerative lesions in the forestomachs and lymphoid tissues
177 that are indistinguishable from those caused by *B. coridifolia* poisoning in herbivores (18).
178 More recently, ingestion of the pollen beetle *Astylus atromaculatus* has been associated with
179 acute necrotizing gastrointestinal disease in herbivores (6). In the present case, the absence of
180 epidemiological evidence of exposure to toxic contaminants or insect ingestion, together with
181 the identification of *B. coridifolia* in the grazing area and compatible clinicopathological
182 findings, supported the final diagnosis.

183 Species of the genus *Baccharis*, including *B. coridifolia* and *B. megapotamica*, are
184 widely known for their toxicity, which is attributed to macrocyclic trichothecenes produced by
185 fungi associated with the plants (8, 22, 11). Recent studies have expanded the characterization
186 of these toxins, including the identification of novel malonyl-glucose conjugates in *B.*
187 *coridifolia* associated with spontaneous poisoning outbreaks in cattle (11). This highlights the
188 significant toxic potential of these plants and reinforces their prominence in endemic areas. The
189 abundant presence of *B. coridifolia* in the native pasture area where the llama was introduced
190 strongly supports ingestion of this plant as the key factor behind the clinical signs and
191 subsequent death.

192 Prevention of *B. coridifolia* toxicosis relies on careful management of susceptible
193 animals, particularly those newly introduced into pastures invaded by the plant. The risk of
194 poisoning is increased in hungry or stressed animals and in areas with limited forage availability
195 (19). Preventive measures include gradual adaptation to invaded pastures, removal of the plant
196 from grazing areas when feasible, and the provision of adequate forage to reduce plant
197 consumption (2, 19).

198 This is the first case report of *B. coridifolia* intoxication in a New World camelid and
199 expands current knowledge regarding animal species susceptible to this plant. The clinical signs

200 associated with gross and histological lesions observed in the llama were consistent with those
201 described in other herbivores, supporting the final diagnosis.

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203 **Data Availability**

204 All the original contributions presented in this study are included in the article. Further
205 inquiries can be directed to the corresponding author.

206

207 **Author Contributions** **Anna Laura de Oliveira Cunha:** Investigation, Data curation,
208 Formal analysis, Writing - original draft preparation. **Gustavo Willian Pandolfo:** Investigation,
209 Writing – review and editing. **Stephane Reinhold Dal Molin:** Investigation, Writing – review
210 and editing. **Maria Augusta Fornara:** Investigation, Writing – review and editing. **Roseli Lopes**
211 **da Costa Bortoluzzi:** Formal analysis, Writing – review and editing. **Renata Assis Casagrande:**
212 Investigation, Data curation, Formal analysis, Supervision, Writing – review and editing.
213 **Claudia Salete Wisser:** Investigation, Data curation, Formal analysis, Supervision, Writing –
214 review and editing. All authors have read and approved the final version of the manuscript.

215

216 **Conflict of Interest**

217 The authors declare no competing interests.

218

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220 [The authors did not use generative artificial intelligence tools or technologies in creating
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229 **References**

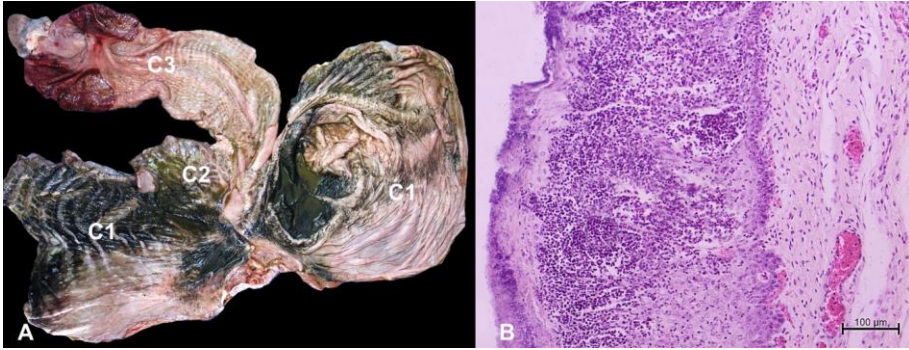
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301
302



303
304 **Figure 1.** Macroscopic and histological lesions of toxic gastritis in a llama (*Lama glama*)
305 caused by *Baccharis coridifolia*. A- First and second gastric compartments (C1 and C2)
306 contained mild congestion in the mucosa. Third compartment (C3): marked mucosal congestion
307 and mild edema. B- Second compartment (C2): mucosal necrosis with cellular debris and a
308 moderate diffuse inflammatory infiltrate of neutrophils and macrophages.

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312 **Figure 2.** Pasture where the llamas were placed the day before death. In detail: *Baccharis*

313 *coridifolia* specimens confirmed by botanical identification.