



## Acute spontaneous and experimental poisoning by *Solanum pseudoquina* in cattle<sup>1</sup>

Elaine Melchiorretto<sup>2</sup> , Daiane Ogliari<sup>2</sup> , Tainara R. Tineli<sup>2</sup> ,  
Francieli A. Molossi<sup>3</sup>  and Aldo Gava<sup>2\*</sup> 

**ABSTRACT.-** Melchiorretto E., Ogliari D., Tineli T.R., Molossi F.A & Gava A. 2024. **Acute spontaneous and experimental poisoning by *Solanum pseudoquina* in cattle.** *Pesquisa Veterinária Brasileira* 44:e07459, 2024. Departamento de Medicina Veterinária, Universidade do Estado de Santa Catarina, Av. Luiz de Camões 2090, Conta Dinheiro, Lages, SC 88520-000, Brazil. E-mail: [aldo.gava@udesc.br](mailto:aldo.gava@udesc.br)

The epidemiology, toxic potential, and clinical and pathological presentation of acute spontaneous and experimental poisoning by *Solanum pseudoquina* are described. In the spontaneous form, the plant was ingested by cattle on two properties, one in the municipality of Canoinhas and the other in Paineel, Santa Catarina. The outbreak in Canoinhas occurred after some trees were felled, five cattle ingested leaves of the plant and showed staring eyes and muscle tremors; four died, and one recovered. On the Paineel property, the outbreak occurred after the pruning of two trees, and two adult cattle ingested the plant and died. The information was provided by the owners, and only one bovine was subjected to autopsy in each outbreak. No lesions were evident at autopsy, and no material was collected for histological evaluation. In the experimental form, green leaves of *S. pseudoquina* were collected in the municipalities of Canoinhas, Paineel and Urubici, in Santa Catarina. The leaves were administered orally to four cattle. Two cattle received a single dose of 40g/kg, one received two doses of 35g/kg, and another received six doses of 20g/kg. One of the animals that received the 40g/kg dose died without showing any clinical signs. The other animals showed apathy, muscle tremors, ataxia, motor incoordination, and difficulty getting up. At necropsy, cardiac alterations were observed in the cattle that received repeated doses of 20g/kg, namely hydropericardium and ventricular dilation, and liver congestion was observed in all the cattle. Microscopic examination showed mononuclear infiltrates in the heart samples of the four cattle (stained with hematoxylin and eosin – HE), which were mild, perivascular and between fiber bundles. Cardiomyocytes had multifocal cytoplasmic hypereosinophilia and pyknotic nuclei. The livers of all four cattle showed moderate congestion between the sinusoids. The anti-troponin immunohistochemistry (IHC) technique was performed on three heart samples and showed cardiomyocytes with decreased troponin C expression in the areas that corresponded to cardiomyocyte hypereosinophilia of varying intensity. *S. pseudoquina* has been shown to be potentially toxic to cattle when doses of more than 20g/kg are ingested.

INDEXING TERMS: Acute cardiomyopathy, *Solanum pseudoquina*, toxic plants, cattle.

**RESUMO.- [Intoxicação aguda espontânea e experimental por *Solanum pseudoquina* em bovinos.]** Descrevem-se a epidemiologia, potencial tóxico, quadro clínico e patológico da intoxicação espontânea e experimental aguda por *Solanum*

*pseudoquina*. Na forma espontânea a planta foi ingerida por bovinos em duas propriedades, uma situada no município de Canoinhas e outra em Paineel, Santa Catarina. O surto de Canoinhas ocorreu após a derrubada de exemplares da árvore e, cinco bovinos que ingeriram folhas da planta manifestaram olhar atento, tremores musculares; destes, quatro morreram e um se recuperou. Na propriedade de Paineel o surto ocorreu após a poda de duas árvores, no qual dois bovinos adultos ingeriram a planta e foram encontrados mortos. As informações foram fornecidas pelos proprietários e apenas um bovino foi necropsiado em cada surto, não foram evidenciadas lesões na necropsia e não foi coletado material para avaliação histológica. Para reprodução experimental, folhas verdes de *S. pseudoquina* foram coletadas nos municípios de Canoinhas,

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<sup>2</sup> Departamento de Medicina Veterinária, Centro de Ciências Agroveterinárias (CAV), Universidade do Estado de Santa Catarina (UDESC), Av. Luiz de Camões 2090, Bairro Conta Dinheiro, Lages, SC 88520-000, Brazil. \*Corresponding author: [aldo.gava@udesc.br](mailto:aldo.gava@udesc.br)

<sup>3</sup> Setor de Patologia Veterinária, Departamento de Patologia Clínica Veterinária, Faculdade de Veterinária, Universidade Federal do Rio Grande do Sul (UFRGS), Av. Bento Gonçalves 9090, Prédio 42505, Porto Alegre, RS 91540-000, Brazil.

Painel e Urubici, localizados em Santa Catarina. As folhas foram administradas por via oral para quatro bovinos. Dois bovinos receberam dose única de 40g/kg, um recebeu duas doses de 35g/kg e outro recebeu seis doses de 20g/kg. Um bovino que recebeu 40g/kg morreu sem serem observados sinais clínicos. Os demais apresentaram apatia, tremores musculares, ataxia, incoordenação motora e dificuldade para levantar. Na necropsia, foram observadas alterações cardíacas, caracterizadas por hidropericárdio e dilatação ventricular no bovino que recebeu doses repetidas de 20g/kg e em todos os bovinos foi observada congestão hepática. O exame microscópico revelou nas amostras cardíacas dos quatro bovinos que foram coradas com hematoxilina e eosina (HE), infiltrado mononuclear, leve, perivascular e por entre feixes das fibras. Cardiomiócitos com hipereosinofilia citoplasmática, multifocal e núcleos picnóticos. No fígado dos quatro bovinos havia congestão, moderada entre os sinusóides. A técnica de imunohistoquímica (IHQ) anti-troponina foi realizada em três amostras cardíacas, as quais apresentaram cardiomiócitos com diminuição da expressão da troponina C nas áreas que corresponderam com hipereosinofilia de cardiomiócitos de diferentes intensidades. *S. pseudoquina* demonstrou potencial de tóxico para bovinos quando ingeridas doses superiores a 20g/kg.

TERMOS DE INDEXAÇÃO: Cardiomiopatia aguda, *Solanum pseudoquina*, plantas tóxicas, bovinos.

## INTRODUCTION

*Solanum pseudoquina* A. St.-Hil. belongs to the Solanaceae family and is mainly found in secondary forests on high ground (Lorenzi 2000, Santos et al. 2015). In areas adjacent to roads and pastures, it becomes an infestation. This tree can reach a height of seven meters and has an erect, cylindrical trunk with thin, smooth bark. Its crown has a subglobose shape and is made up of alternate, simple leaves. In Santa Catarina it is popularly known as “canema” and in other regions of Brazil as “coerana”, “tintureiro”, “buquê-de-noiva”, “coerana-do-mato”, “quineira” (Lorenzi 2000).

In Santa Catarina, two plants have been described as causing cardiac alterations in cattle. *Amorimia exotropa* is found on the south coast of the state and causes sudden death (Gava et al. 1998) and *Ateleia glazioviana* is found in the center-west and west of the state and causes heart failure and/or sudden death (Gava & Barros 2001, Gava et al. 2001), abortion (Stolf et al. 1994), and neurological damage (Gava & Barros 2001, Gava et al. 2001).

*Solanum pseudoquina* has been identified as a possible cause of heart disease in cattle and has been studied since 1991. However, there was no concrete data on its toxicity in cattle. In 1991 and 2020, sudden cattle deaths occurred on two properties, one in the municipality of Canoinhas and the other in Painel, Santa Catarina. In both outbreaks, the owners reported that the cattle had eaten green leaves of *S. pseudoquina* after the trees had been felled. The aim of this study was to describe the epidemiology and clinical and pathological aspects of spontaneous and experimental poisoning by *S. pseudoquina* in cattle.

## MATERIALS AND METHODS

**Ethical approval.** This study was evaluated by the Ethics Committee for the Use of Animals (CEUA) of the “Universidade do Estado de Santa Catarina” (UDESC) and approved under number 7257120820.

The history of the two outbreaks of a disease that rapidly affected cattle was collected. The first outbreak occurred in 1991 in the municipality of Canoinhas, located on the northern plateau of Santa Catarina, and the second occurred in 2020 in the municipality of Painel, on the southern plateau.

For the experiment, green leaves of *Solanum pseudoquina* (Fig.1) were collected in the municipalities of Canoinhas, Painel, and Urubici and administered orally to four cattle (Bovines 1, 2, 3, and 4). Bovine 1 and 2 received a single dose of 40g/kg, Bovine 3 received two doses of 35g/kg over 48 hours, and Bovine 4 received six doses of 20g/kg over 23 days (Table 1). The leaves were kept on wooden platforms and boxes and covered with raffia bags to reduce aeration and drying of the leaves.



Fig.1. Adult specimen of *Solanum pseudoquina*. Urubici/SC.

Throughout the experimental period, the cattle were kept on the premises of the “Centro de Ciências Agroveterinárias” (Agricultural and Veterinary Sciences Center – CAV) of the UDESC in a picket with Kikuyu grass (*Pennisetum clandestinum*) and water *ad libitum*. Clinical examinations were carried out daily to assess heart rate, respiratory rate, and rumen movements and observe the animals' behavior.

After the cattle died, a necropsy was performed, and samples were taken from the heart, liver, kidneys, lungs, pre-stomach, abomasum, intestines, central nervous system, lymph nodes, adrenal glands, pancreas, thyroid and parathyroid glands. They were fixed in 10% buffered formalin, embedded in paraffin, cut at 5µm, and stained with hematoxylin-eosin (HE).

Samples of heart fragments from Bovines 1, 2, and 4 were analyzed by immunohistochemistry (IHC) using troponin C antibody (anti-cTnC). Positive slides were used (Imuno-Slide-EasyPath®) to perform this technique; the histological sections were deparaffinized in xylene, rehydrated in alcohol, dipped in a 10% hydrogen peroxide solution for 15 minutes to block endogenous peroxidases, and washed with distilled water. For antigen recovery, a pressure cooker (DAKOCITOMAKER®) was used; the slides were dipped in TRIS EDTA buffer solution (pH=9) for 3 minutes at a temperature of 125°C. Five percent (5%) skimmed milk (Molico®) was used for 15 minutes to block non-specific reactions. The sections were incubated overnight with the anti-human cTnC antibody (Novo Castra) at a dilution 1:40 in a dark, humid chamber. After incubation, the samples were washed with distilled water, and the MACH-4 detection system was used (10 minutes in an oven). The sections were stained with AEC chromogen (DAKO®), counterstained with Harris hematoxylin for 50 seconds, and mounted for viewing under an optical microscope.

The samples submitted to IHC were evaluated under an optical microscope and compared with a negative internal control slide for anti-cTnC antibodies.

For the botanical identification of the plant, samples were collected and sent to the Lages Herbarium (LUSC) of the UDESC and identified by Bortulizzi R.L.C.

## RESULTS

### Spontaneous poisoning

In Canoinhas, in 1991, four of the five cattle that fell ill died quickly after consuming specimens of the plant identified as *Solanum pseudoquina*. One cow that fell ill recovered from

the acute phase and some months later developed edema in the chest area. The second outbreak occurred in 2020 in the municipality of Paineal. After two *S. pseudoquina* trees were felled, one cow and a heifer were found dead the morning after ingesting the plant's leaves. The main clinical signs were apathy, staring eyes (Bovine 1 and 4), and remaining in sternal decubitus; the animals had difficulty getting up, and when they did, they showed motor incoordination and difficulty walking.

One bovine from each outbreak was submitted for autopsy; no macroscopic alterations were observed, and no samples were taken for histological evaluation.

### Experimental poisoning

Bovines 1, 3, and 4 began to show clinical changes between 30 minutes and 13 hours after being given the plant. The main clinical signs were apathy, frightened and attentive eyes (Bovine 1 and 4), remaining in the sternal decubitus position for a long period, difficulty in getting up, and once they managed to get up, they walked cautiously and showed motor incoordination. Muscle tremors were observed throughout the body in all three cattle, which were more intense in the pelvic limbs. Bovine 3 had convulsions, Bovine 3 and 4 had sialorrhea, and Bovine 1 had bloody stools (Table 2). The four cattle kept their appetite until near death. Bovine 2 showed no clinical changes and was found dead in the morning, 17 hours after ingesting the 40g/kg dose. Bovines 1, 2, and 4 died between three and 25 hours after being fed the plant.

Macroscopically, Bovine 4 showed mild hydrothorax, moderate amounts of hydropericardium and fibrin floating in the pericardial fluid (Fig.2). The heart showed bilateral ventricular dilatation and some petechiae distributed throughout the epicardium (Fig.3); Bovine 3 presented areas of mild pallor in the myocardium. The livers of all bovines were dark red, and a large amount of blood flowed from the cut.

The histological changes were cytoplasmic hypereosinophilia and pyknosis of cardiomyocytes, lymphocyte infiltrates that varied from mild to moderate between cardiomyocytes and around the vessels, in some of which there was edema and collagen proliferation (Fig.4).

**Table 1. Acute experimental poisoning by *Solanum pseudoquina* in cattle, general data**

Cattle	Sex	Weight (kg)	Collection location	Year	Dose (g/kg)	Number of administrations	Total plant consumed (kg)
1	Male	70	Canoinhas	1991	40	1	2.8
2	Female	100	Canoinhas	1991	40	1	4.0
3	Female	316	Urubici	1997	35	2	22
4	Female	380	Paineal and Urubici	2021	20	6	40.8

**Table 2. Clinical progression of experimental poisoning by *Solanum pseudoquina* in cattle**

Cattle	Dose (g/kg)	Onset of clinical signs (h) after completion of administration	Death (h) after completion of administration	Clinical progression (h)	Muscle tremors, motor incoordination, frequent ear movement	Difficulty standing	Sialorrhea	Convulsion	Feces with blood
1	40	8	25	17	X	X	-	-	X
2	40	NO	17	-	-	-	-	-	-
3	35	0:30	3	02:30	X	X	X	X	-
4	20	13	23	10	X	X	X	-	-

NO = not observed.

In the immunohistochemical labeling for anti-cTnC, the three tested samples (1, 2, and 4) showed cardiomyocytes with a slight, diffuse decreased immunolabeling (Fig.5), and few cardiomyocytes showed strong marking of intracellular troponin (normal).

## DISCUSSION

The ingestion of green leaves of *Solanum pseudoquina* has been shown to have a toxic and cumulative effect in cattle. The clinical condition developed more rapidly in the bovine that received two doses of 35g/kg with a 24-hour interval (Bovine 3) and in Bovine 4, which died 10 hours after receiving six doses of 20g/kg (the last dose was given 48 hours after the fifth dose). With regard to the cattle that received a single dose of 40g/kg, Bovine 1 had a clinical course of 17 hours and Bovine 2 was found dead in the morning in the stall, 17 hours after ingesting the plant. The time of disease progression observed in the cases of experimental poisoning is in line

with that observed in cases of spontaneous poisoning, and the higher the dose, the faster the clinical progression.

The clinical-pathological findings of motor incoordination, liver congestion, and fluid accumulation in the pericardium and thorax are possibly related to the plant's direct action on the myocardium. The hypereosinophilia and pyknosis of cardiomyocytes associated with the mononuclear infiltrate and edema in the adventitial layer of the vessels possibly caused a decrease in oxygenation of the cardiac fibers, leading to a moderate decrease in cardiac troponin in the fibers in a focally extensive manner that was sufficient to cause heart failure.

Macroscopic and microscopic myocardial lesions were discreet, and troponin C labeling in the cases evaluated in this study was moderate and focally extensive, which differs from cases of *Amorimia exotropicalis* poisoning that can cause cardiac myocardial necrosis (Gava et al. 1998). Troponin labeling shows clusters of intensely affected cardiomyocytes, i.e., negative for troponin C labeling (Santos et al. 2016). *A. exotropicalis* is found on the southern coast of the country (Gava

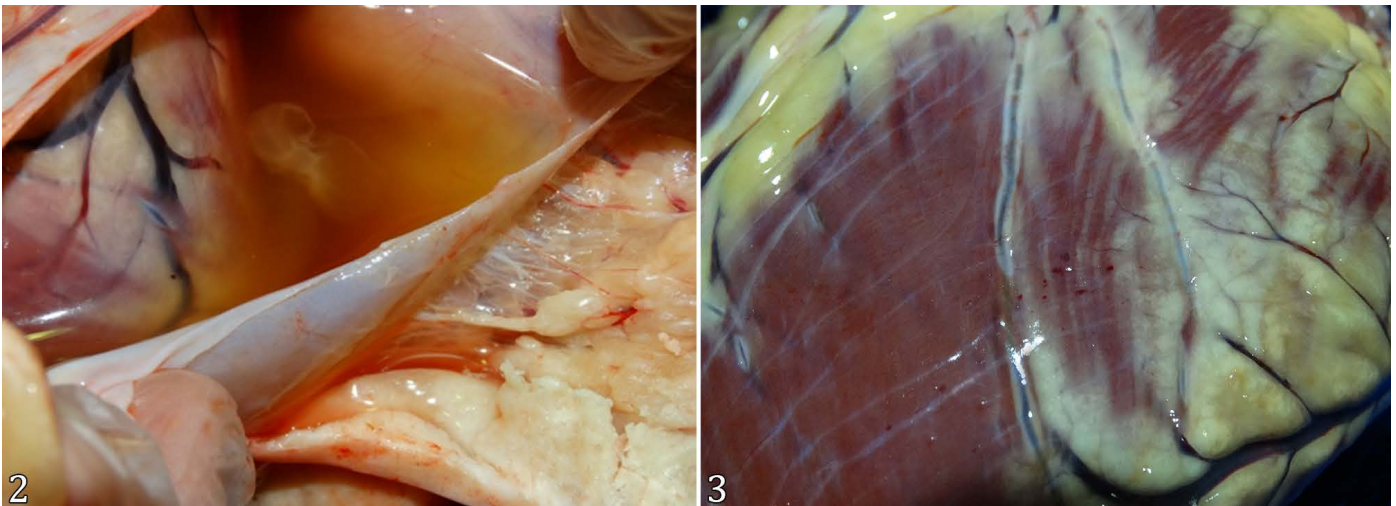


Fig.2-3. Macroscopy of the heart of Bovine 13 (20g/kg of *Solanum pseudoquina*). (2) Hydropericardium with floating fibrin. (3) Petechiae in the pericardium. Lages/SC, 2021.

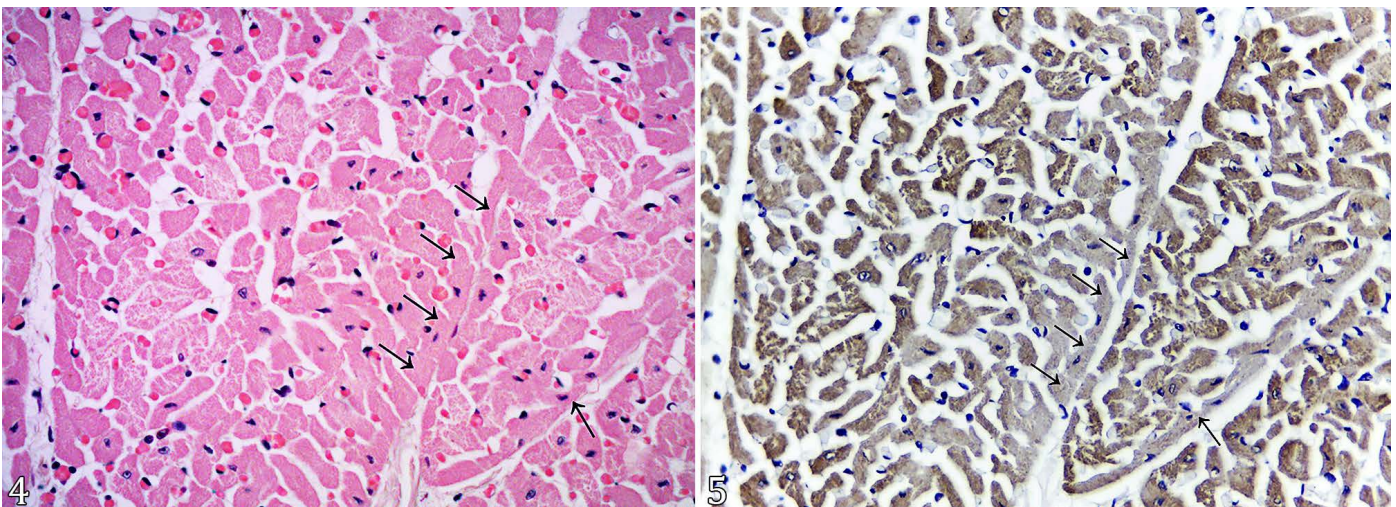


Fig.4-5. Histological cardiac lesions of Bovine 13 (20g/kg *Solanum pseudoquina*). (4) Cardiomyocytes with cytoplasmic hypereosinophilia and pyknosis (arrows). HE, obj.40x. (5) Decreased expression of cardiomyocyte troponin (arrows). Anti-troponin IHC, obj.40x. Lages/SC, 2023.

et al. 1998, Pavarini et al. 2011) but not in the Planalto regions where natural cases of *S. pseudoquina* poisoning have occurred.

Poisoning by *Ateleia glazioviana* can manifest in two cardiac forms: sudden death and congestive heart failure. Experimentally, with doses above 70g/kg, this plant caused marked hypereosinophilia and pyknosis in clusters of cardiomyocytes, as was observed in the present study. This plant is only found in the western regions of Santa Catarina and Rio Grande do Sul (Gava & Barros 2001, Gava et al. 2001).

Other plants of the same genus have been described as toxic to cattle, but the clinical signs and lesions are very different from those produced by *S. pseudoquina*. *Solanum fastigiatum* var. *fastigiatum* causes nerve signals and damage to the nervous system (Riet-Correa et al. 1983, Rech et al. 2006) and *Solanum malacoxylon* is known to cause metastatic calcification in various organs, including the heart (Döbereiner et al. 1971).

## CONCLUSIONS

*Solanum pseudoquina* has toxic potential and can be voluntarily ingested by cattle and cause their death when doses above 20g/kg are ingested without leading to significant macroscopic alterations.

Acute poisoning by *S. pseudoquina* can be the cause of histological lesions in the myocardium of cattle.

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**Conflicts of interest statement.**- The authors declare no conflicts of interest.

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