Solidago species in grasslands of Paraguay and their relationship to hepatic photosensitivity in cattle

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Abstract

Paraguayan livestock production uses forage grasses as a basic diet. Many species of weeds grow in these pastures, and some of them, like the *Solidago* genus, are toxic to the animals. This genus is reported to cause hepatic photosensitivity in cattle due to the toxic compound, saponins, contained mainly in the leaves. Saponins induce liver damage because they hamper the breakdown of photodynamic metabolites like phylloerythrin, formed from chlorophyll metabolism. Some species of *Solidago* are recognized in South America, but only two species are reported in Paraguay, and have been a cause of confusion in their identification and distribution due to the great morphological similarity they have. In the past, *Solidago chilensis* was the only species recorded in Paraguay and was related to causing hepatic photosensitivity in cattle. However, recent studies of the genus have demonstrated that *Solidago microglossa* is the dominant species of the genus *Solidago* in Paraguay, widely distributed across these grasslands. Therefore, the objective of this research is to define the dominant species of *Solidago* in Paraguay and as the primary cause behind photosensitive health disorders in cattle.

Keywords: *Solidago* spp., weeds, photosensitivity, cattle.

Espécies de *Solidago* em pastagens do Paraguai e sua relação com a fotossensibilidade hepática em bovinos

Resumo

A produção pecuária paraguaia utiliza gramíneas forrageiras como dieta básica. Muitas espécies de plantas daninhas crescem nessas pastagens e algumas de las, como o gênero Solidago, são tóxicas para os animais. Relata-sé que esse gênero causa fotossensibilidade hepática em bovinos devido ao composto tóxico, saponinas, contido principalmente nas folhas. As saponinas induzem danos ao fígado porque dificultam a quebra de metabólitos fotodinâmicos como a filoeritrina, formada a partir do metabolismo da clorofila. Algumas espécies de Solidago são reconhecidas na América do Sul, más apenas duas espécies são relatadas no Paraguai e têm sido causa de confusão em sua identificação e distribuição devido à grande similaridade morfológica que apresentam. No passado, S. chilesis foi a única espécie registrada no Paraguai e relacionada a causar fotossensibilidade hepática em bovinos. No entanto, estudos recentes do gênero demonstraram que *Solidago microglossa* é a espécie realmente dominante do gênero Solidago no Paraguai, amplamente distribuída por essas pastagens. Portanto, o objetivo desta pesquisa é definir as espécies dominantes de Solidago no Paraguai e como a principal causa dos distúrbios de saúde fotossensíveis em bovinos.

Palabras-chave: *Solidago* spp., plantas daninhas, fotossensibilidade, bovinos.

1. Introduction

The grasslands used in livestock farming occupy a large surface area that covers 18,000,000 hectares, both in the Eastern and Western regions of Paraguay (ARP 2017). Several weed species grow in these spaces, some of them being toxic to livestock (Basualdo et al., 1992; Harasymowycz, 2015). The Solidago genus is reported to cause

hepatic photosensitivity in cattle due to the saponins that occur especially in the leaves, which is why it constitutes a weed of interest in meat production (Arambarri; Hernández, 2014; Peralta; Klich, 2021). Several species of the genus Solidago are identified in the American continent, but in the South American region, only two are present, *Solidago chilensis* and *Solidago microglossa* (Figure 1) (López; Semple, 2015) (Figure 1).

Both species are reported in Paraguay and have been a cause of confusion in their identification and distribution due to their great morphological similarity they have. In the past, *S. chilensis* was the only species recorded in Paraguay, even though Vogt (2012) and Degen et al. (2016) recognized it only in the departments of Cordillera, Presidente Hayes, and Alto Paraguay, with a greater distribution in northwestern Argentina.

However, new studies only locate it in the Departments of Cordillera and Alto Paraguay, having a greater distribution in northwest Argentina (Zuloaga et al., 2008). López & Semple (2015) only record the species *S. microglossa* in Paraguay, while the species *S. chilensis* preferentially develops in Argentine territory due to its affinity for a climate with cooler temperatures.

According to López & Semple (2015) and De Egea et al. (2018), both species are fundamentally differentiated by the stem pilosities, being longer and denser in *S. microglossa* (1-1.5 mm in length in the middle section of the stem and 0.6 to 1.2 mm in the upper section) and very small and with lower density in *S. chilensis* (0.1 -0.4 mm in length in the middle and upper section of the stem), this being considered an inherent characteristic, little influenced by the environment. The objective of this research is to define the dominant species of *Solidago* in Paraguay and their relationshipp to hepatic photosensitive health disorders in cattle.

Figure 1. *Solidago chilensis* plant (Salta, Argentina) (A) and *Solidago microglossa* plant (Caaguazú, Paraguay) (B). Source: Humberto Sarubbi, 2025.

2. Materials and Methods

2.1 Specimen collection

Between February and April 2023, 30 specimens of the genus *Solidago* (5 plants per sampling site), were collected in a natural area with livestock pasture of the oriental region of Paraguay (Central, Cordillera, Paraguarí, Caaguazú and Misiones Departments), that reported the presence of the species in Paraguay (Table 1). This region is a thermo-mesophilic region where the biome is made up of three groups in irregular and heterogeneous masses and clumps. The vegetation in open spaces, such as savannas and wetlands, corresponds mainly to an herbaceous layer of Poaceae, such as *Andropogon lateralis* and *Hemarthria altissima*, which are used for feeding cattle (Avila-Torres et al., 2018). The samples were brought to the Botany Laboratory (FCQ-UNA) for identification and comparison with the samples recorded in the FCQ Herbarium.

2.2 Macroscopic and microscopic identification of Solidago species

Macroscopic analyses were conducted on herbarium specimens, including those collected in the field, using a binocular stereoscopic microscope to examine the presence and distribution of trichomes on stems and

leaves—key diagnostic features for both species, as described by López & Semple (2015) in their identification key for the genus *Solidago*. Photographic documentation of the samples was carried out, and scanning electron microscopy (SEM-EDS Zeiss Evo 15) images of the stems were obtained to compare trichome density and length.

Table 1. Coordinates of sampling locations in the 5 Departments of the oriental region of Paraguay.

Deparment	Coordinates
Central	25°12'34.9"S 57°24'44.2"O
Cordillera	25°12'09.3"S 57°21'41.1"O
Paraguarí	26°14'42.2"S 57°09'44.8"O
Caaguazú	24°58'36.0"S 56°20'57.5"O
Misiones	26°30'18.8"S 57°05'16.3"O

Source: Authors, 2025.

3. Results

3.1 Solidago chilensis and Solidago microglossa

The *Solidago chilensis* and *S. microglossa* are perennial plants erect, medium-sized, up to 1 m tall. It has rhizomes with an unbranched stem and abundant leaves. The leaves are simple, alternate, sessile, lanceolate, acuminate, and with entire margins. The inflorescences are triangular, yellow panicles. The fruits are dry, achene-type. The samples observed in the FCQ Herbarium were 41 (from Central, Cordillera, Paraguarí, Caazapá, Caaguazú, Guairá, Itapúa, Canindeyú, and Presidente Hayes Departments), and all correspond to the species *S. microglossa*, with dense and abundant hairiness observed on the stems (hispid-villose) and leaves. Only three samples, from the Presidente Hayes and Itapúa Departments (Paraguay), corresponded to the species *S. chilensis* (Figure 2). Likewise, all samples collected in the field had moderately to densely pubescent stems and leaves according to the description of *S. microglossa* (FCQ Herbarium code: Degen et Sarubbi 4828) (Figure 3). The average length of the hairs on the stems of the *S. chilensis* samples was 0.2 to 0.18 mm, while *S. microglossa* had an average of 1.2 to 1.4 mm.

Figure 2. Specimens of *Solidago chilensis* (Herbario FCQ-UNA) from Presidente Hayes, FCQ Herbarium code: Mereles et Degen 5202 (A) from Itapúa, FCQ Herbarium code: 1685 González Parini et González Salema, Paniagua (B), and *Solidago microglossa* from Cordillera, FCQ Herbarium code: 1693 DeEgea (C). Source: Humberto Sarubbi, 2025.

4. Discussion

The morphology description and hair leaves and stem measurements were similar for *Solidago microglossa*

described by López & Semple (2015). Therefore, it is recognized that there is a high incidence of *S. microglossa* in the Eastern region of Paraguay and that it is the dominant species. *S. microglossa* is known from Bolivia, Paraguay, Brazil, and northern Argentina (López; Semple, 2015). According to Basualdo et al. (1992) and Harasymowycz (2015), *S. chilensis* is the species that causes hepatic photosensitivity in cattle in Paraguay due to the saponin content in the leaves. Saponins are toxic to the liver, causing secondary photosensitivity, manifesting skin problems; when the damage is very severe, it can cause death without presenting these signs (Peralta; Klich, 2021). But due to its very limited distribution, it is presumed that *S. microglossa* is responsible for photosensitive health disorders in animals. Although some researchers, such as Chicourel et al. (1998) and Pedroso et al. (2009) have not detected saponins in samples of *S. microglossa*, others, such as Baggio et al. (2012), have detected the presence of saponins in the plant, especially in the leaves.

Similarly, Gastaldi et al. (2018) concluded that the phytochemical properties of both species are the same. Also, the non-detection of saponins may be because the Solidago species presents variation in chemical composition in the different seasons of the year, considering that saponins are detectable in summer and autumn (Chicourel et al. 1998; Gastaldi et al. 2018). Therefore, *S. microglossa* is considered to have the highest incidence of *Solidago* species in Paraguay and could be responsible for the majority of cases of hepatic photosensitivity in cattle reported in several Departments of the eastern and western regions of Paraguay (Basualdo et al., 1992; Harasymowycz, 2015). Further phytochemical studies in Paraguay of the *Solidago microglossa* species are needed.

Figure 3. A, Glabrous stem of *Solidago chilensis* collected in Salta, Argentina. B-C, Tomentose stem of *S. microglossa* D, Electron photomicrograph of *S. chilensis* stem E, electron photomicrograph of *S. microglossa* stem collected in Paraguarí, Paraguay. Barra: D-E = 500 µm. Source: Authors, 2025.

5. Conclusions

According to observations made both in the field and in the FCQ Herbarium, it can be concluded that the predominant species in the grassland of Paraguay is *Solidago microglossa* and could be associated with most cases of hepatic photosensitivity in cattle in Paraguay.

6. Authors' Contributions

Humberto Sarubbi: He made contributions to the conception, design of the work, the acquisition, analysis, and interpretation of data, and drafted the work. *Rosa Degen*: She made contributions to the conception and design of the work; the acquisition, analysis, and interpretation of data; and substantively revised it.

7. Conflicts of Interest

No conflicts of interest.

8. Ethics Approval

Not applicable.

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