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ORIGINAL ARTICLE

Phytochemistry in Medicinal Species of *Solanum* L. *(Solanaceae)*

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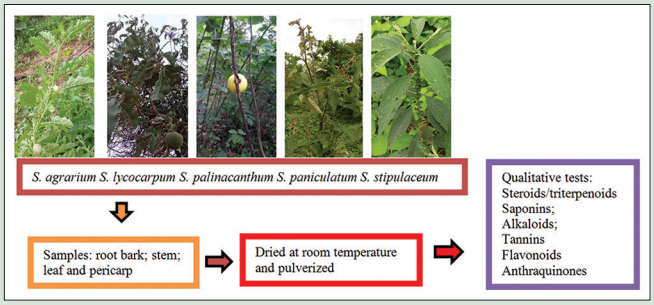
ABSTRACT

Background: The genus *Solanum* L. is the largest of the family *Solanaceae*; it has used in food, ornamentation, and medicinal. **Objective:** This work had as objective to perform the phytochemical screening secondary metabolites: saponins, alkaloids, tannins, flavonoids, and anthraquinones by means of colorimetric and precipitation analyzes of root bark, stem, leaf, and epicarp of the following species of *Solanum* genus: *Solanum agrarium, Solanum lycocarpum, Solanum palinacanthum, Solanum paniculatum,* and *Solanum stipulaceum*. The species are found in areas of the Cerrado Biome of Northern Minas Gerais state for initial evaluation of the possibility of cultivation for medicinal use. **Materials and Methods:** The following qualitative tests were performed: Liebermann–Burchard reaction for steroids/triterpenoids; foam persistence test for saponins; Bertrand and Dragendorff reagents for alkaloids; reactions with lead neutral acetate at 10% and ferric chloride at 2% for tannins; reactions with ferric chloride at 2% and Shinoda reaction for flavonoids; reaction of Bornträeger and reaction with sodium hydroxide at 0.5% for anthraquinones. **Results:** Plants of the *Solanum* L. genus, occurring in Cerrado areas in the city of Montes Claros, have considerable amounts of secondary metabolites, varying between the different species and in different structures analyzed. **Conclusion:** It is important to continue the study evaluating whether in species from planting occurs production of the secondary metabolites identified in wild plants.

Key words: *Solanum agrarium, Solanum lycocarpum, Solanum palinacanthum, Solanum paniculatum, Solanum stipulaceum*

SUMMARY

- The genus *Solanum* L. is the largest of the family *Solanaceae*; it has uses in food, ornamentation, and medicinal. Phytochemical screening allowed the identification of secondary metabolites such as saponins, alkaloids, tannins, flavonoids, and anthraquinones. Plants of the *Solanum* L. genus, occurring in Cerrado areas of the city of Montes Claros, have considerable amounts of secondary metabolites, varying among the different species and in the different structures analyzed.



Abbreviations Used: FAPEMIG: Fundação de Amparo à Pesquisa do Estado de Minas Gerais, CNPq: Conselho Nacional de Desenvolvimento Científico e Tecnológico, BHCB: Herbarium of the Department of Botany, from Institute of Biological Sciences, Federal University of Minas Gerais.

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INTRODUCTION

Solanaceae is a particularly interesting angiosperm family, has about 98 genera and 3000 species, and makes the members of this family having morphological and ecological characteristics diversified and cosmopolitan distribution, being that many of which are used in food, in ornamentation, and as a medicinal resource.[1,2]

The genus *Solanum* L. is the largest of the *Solanaceae* family with approximately 1500 species, found in tropical and subtropical regions of the planet. In Brazil, they are found especially in the south and southeast region.[3,4]

For the *Solanum agrarium* species, previous studies indicated antispasmodic activity of the ethanol extract of the aerial parts.[5] For the leaves of *Solanum lycocarpum* was identified antibacterial activity, by the presence of tannins,[6,7] tthe antihelmintic action was attributed to the presence of steroidal alkaloids[8,9] and trypanosomicidal action was attributed to the ethanol extracts fruits of *Solanum lycocarpum and Solanum palinacanthum*.[10]

Extracts from the leaves of *Solanum paniculatum* promote anticancer activity,[11] and the aqueous fraction of the ethanol stratum of *Solanum stipulaceum* stem has hypotensive activity.[12]

The cultivation of wild plants represents an artifice for the maintenance of biodiversity. To initiate this activity, on a larger scale, when it comes to a medicinal plant, it is fundamental to know its medicinal potential and which compounds are involved in its biological activities.[13,14]

Based on an assumption, the qualitative phytochemical analysis is of great importance for the preliminary evaluation of plant species that do not yet have studies of the chemical profile. This technique allows to identify the presence of groups of secondary metabolites that may be of interest for the development of new drugs, to suggest which plant structure that the compounds of interest are found in greater quantity and could thus be candidates for the production of phytotherapeutic medicine, besides to indicate species with potential for use by the pharmaceutical industry and can be grown.[15,16] Studies about the structure and histochemistry of these species have been described by Matias *et al*.[17]

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This work aimed to identify the classes of secondary metabolites by phytochemical tests in species of the genus *Solanum: S. agrarium, S. lycocarpum, S. palinacanthum, S. paniculatum,* and *S. stipulaceum*, wild plants occurring in Cerrado areas, in the city of Montes Claros, MG, Brazil (16°52'15" S, 44°00'58"W). Exsicates were deposited in the BHCB Herbarium, of the Department of Botany, from Institute of Biological Sciences, Federal University of Minas Gerais, Brazil (Mercadante-Simões 10-14, registration number 116081 and 168587-168590 respectively, identified by LL Giacomin).

MATERIALS AND METHODS

Samples (root bark, stem, leaf, and pericarp) were collected from three individuals of each one of the species studied. The vegetable material was dried at room temperature and pulverized in TE-648 knife mill (Tecnal, Ourinhos, Brazil). The following tests qualitative were performed: Liebermann–Burchard reaction for steroids/triterpenoids; foam persistence test for saponins; Bertrand and Dragendorff reagents for alkaloids; reactions with lead neutral acetate at 10% and ferric chloride at 2% for tannins; reactions with ferric chloride at 2% and Shinoda reaction for flavonoids; reaction of Bornträeger and reaction with sodium hydroxide at 0.5% for anthraquinones; following protocols established by Mouco *et al*.[18] and Silva *et al*.[19] modified.

RESULTS AND DISCUSSION

Tannins are present in the root barks of all species in moderate amounts [Table 1]. This group of metabolites is related to activities such as antidiarrheal, diuretic, anti-inflammatory, antiseptic, antioxidant, and hemostatic.[6,20] In addition to acting regulating enzymes, stimulating the phagocytic cells involved in wound-healing processes.[21]

These compounds are also related to actions: antibacterial, antifungal, and antiviral, which may be due to the ability of tannins to complex macromolecules, such as proteins and polysaccharides.[7]

Flavonoids were detected in the root bark of all species, except in *S. agrarium*. It can be verified also alkaloids in *S. agrarium* and *S. palinacanthum*, and this last one highlighted by the presence of tannins, flavonoids, and alkaloids [Table 1]. The presence of these three groups of metabolites together is associated with the potential antibacterial activity of medicinal plants.[22]

The species *S. agrarium* and *S. palinacanthum* besides presenting alkaloids in the root bark also have them in the stem as can be observed in Table 2. There are reports of several activities for these compounds, such as antihypertensive, antiarrhythmic, antimalarial, anticancer, and analgesic properties. These activities are related to the presence of quinidine, quinine, vincristine, and vinblastine.[17] Some species of the *Solanaceae* family produce tropanic alkaloids of relevant pharmacological importance such as atropine (*Atropa belladonna*), scopolamine, and hyoscyamine (*Hyoscyamus niger*).[23]

Flavonoids were found in the stem of all species studied [Table 2], which are the most frequent class of phenolic compounds in species of the genus *Solanum*, being that the flavonoids most reported for these plants are kanferol, quercetin, and myricetin.[3]

The antioxidant capacity of these substances eliminates free radicals and thus exerts biological activities to prevent diseases such as cancer, cardiovascular, and neurodegenerative; these activities are attributed mainly to flavonoid quercetin,[24] besides hepatoprotective properties, anti-inflammatory, and antiviral mainly related to the compounds: catechin, apigenin, quercetin, naringenin, rutin, hesperidin, and luteolin.[25]

Several of the studied metabolites were observed in the stem of *S. paniculatum*: alkaloids, flavonoids, tannins, and anthraquinones. Steroids/triterpenoids were found only in *S. agrarium, S. paniculatum,* and *S. stipulaceum*. These last two were the only ones that had saponins in the stems [Table 2].

In leaves of all species, it is possible to observe steroid/triterpenoid, alkaloids, tannins, and flavonoids [Table 3]. It is also observed that only *S. paniculatum* and *S. stipulaceum* species have saponins.

With the exception of the leaves of *S. agrarium*, all have anthraquinones, which are a group of substances for which have already been described biological activities: laxative, diuretic, immunostimulant, antifungal, antipsoriatic, antiviral, and antitumor related to the compounds

Table 1: Phytochemical profile in root bark of *Solanum agrarium, Solanum lycocarpum, Solanum palinacanthum, Solanum paniculatum,* and *Solanum stipulaceum*

Secondary metabolite	Test	ag	ly	pl	pn	st
Steroids/triterpenoids	Liebermann-Burchard	0	0	0	0	0
Saponins	Foam persistence	0	0	0	0	0
Alkaloids	Bertrand	1	0	1	0	0
	Dragendorff	0	0	0	0	0
Tannins	Lead neutral acetate	1	1	0	1	0
	Ferric chloride	1	1	1	1	1
Flavonoids	Ferric chloride	0	0	1	1	1
	Shinoda	0	1	1	1	1
Anthraquinones	Bornträeger	0	0	0	0	0
	Hidróxido de sódio	0	0	0	0	0

0=Absent; 1=Moderate; 2=Accentuated. ag: *Solanum agrarium*; ly: *Solanum lycocarpum*; pl: *Solanum palinacanthum*; pn: *Solanum paniculatum*; st: *Solanum stipulaceum*

Table 2: Phytochemical results in stem of *Solanum agrarium, Solanum lycocarpum, Solanum palinacanthum, Solanum paniculatum,* and *Solanum stipulaceum*

Secondary metabolite	Test	ag	ly	pl	pn	st
Steroids/triterpenoids	Liebermann-Burchard	1	0	0	1	1
Saponins	Foam persistence	0	0	0	1	1
Alkaloids	Bertrand	0	0	0	0	0
	Dragendorff	1	0	1	0	0
Tannins	Lead neutral acetate	0	1	1	0	0
	Ferric chloride	0	1	1	0	0
Flavonoids	Ferric chloride	0	1	1	1	0
	Shinoda	1	1	1	1	1
Anthraquinones	Bornträeger	0	0	1	0	0
	Hidróxido de sódio	0	0	1	0	0

0=Absent; 1=Moderate; 2=Accentuated. ag: *Solanum agrarium*; ly: *Solanum lycocarpum*; pl: *Solanum palinacanthum*; pn: *Solanum paniculatum*; st: *Solanum stipulaceum*

Table 3: Phytochemical results on leaf of *Solanum agrarium, Solanum lycocarpum, Solanum palinacanthum, Solanum paniculatum,* and *Solanum stipulaceum*

Secondary metabolite	Test	ag	ly	pl	pn	st
Steroids/triterpenoids	Liebermann-Burchard	1	1	1	1	1
Saponins	Foam persistence	0	0	0	1	1
Alkaloids	Bertrand	1	1	1	1	1
	Dragendorff	1	1	1	0	0
Tannins	Lead neutral acetate	1	1	1	1	1
	Ferric chloride	1	1	1	1	1
Flavonoids	Ferric chloride	1	1	1	1	1
	Shinoda	1	1	1	1	1
Anthraquinones	Bornträeger	0	1	1	1	1
	Hidróxido de sódio	0	1	1	1	1

0=Absent; 1=Moderate; 2=Accentuated. ag: *Solanum agrarium*; ly: *Solanum lycocarpum;* pl: *Solanum palinacanthum;* pn: *Solanum paniculatum;* st: *Solanum stipulaceum*

Table 4: Phytochemical results in pericarp of *Solanum agrarium, Solanum lycocarpum, Solanum palinacanthum, Solanum paniculatum,* and *Solanum stipulaceum*

Secondary metabolite	Test	ag	ly	pl	pn	st
Steroids/triterpenoids	Liebermann-Burchard	1	1	1	1	1
Saponins	Foam persistence	0	0	0	1	1
Alkaloids	Bertrand	0	1	1	1	1
	Dragendorff	0	1	1	1	1
Tannins	Lead neutral acetate	0	0	1	1	1
	Ferric chloride	1	1	1	1	1
Flavonoids	Ferric chloride	1	1	1	1	1
	Shinoda	1	0	1	0	0
Anthraquinones	Bornträeger	0	1	0	1	1
	Hidróxido de sódio	0	1	0	1	1

0=Absent; 1=Moderate; 2=Accentuated. ag: *Solanum agrarium;* ly: *Solanum lycocarpum;* pl: *Solanum palinacanthum;* pn: *Solanum paniculatum;* st: *Solanum stipulaceum*

chrysophanol and emodin.[26] In addition to antioxidant properties attributed mainly to the anthrone, alizarin and aloe-emodin substances,[27] and antibacterial.[28]

The leaves and pericarp of all species have moderate amounts of steroids/triterpenoids [Tables 3 and 4]; the biological activities reported for these compounds include anticancer, antimalarial, diuretic, and antimicrobial, which are related to the substances artemisinin and glycyrrhizin;[17] anti-inflammatory, analgesic,[16] antispasmodic, anticariogenic, antiviral, hepatoprotective, and cardioprotective.[18,29]

The pericarps of all species had moderate amounts of tannins and flavonoids. The anthraquinones group was observed in the epicarp of the species: *S. lycocarpum, S. paniculatum,* and *S. stipulaceum* [Table 4].

Tannins were found in leaves, root bark, and pericarp of all species. With the exception of the bark of *S. agrarium* roots, the samples of all the other species presented flavonoids. Saponins have been observed only in the species *S. paniculatum* and *S. stipulaceum*, which also have flavonoids [Tables 1-4], there are reports that the use of plant extracts that contain saponins and flavonoids may induce peripheral analgesia.[30]

The group of the alkaloids was observed in the leaves of all the species, already in stem and bark of the root the only species that possess it are *S. palinacanthum* and *S. agrarium*; nevertheless, this last one was the only species in which it was not observed this group of metabolites in the pericarp. The *S. agrarium* species was the only one in which no saponins or anthraquinones were observed in all analyzed structures (root bark, stem, leaf, and pericarp) [Tables 1-4].

CONCLUSION

This work demonstrated that wild plants of the genus *Solanum* L., occurring in Cerrado areas in the city of Montes Claros, have considerable amounts of secondary metabolites, varying between the different species and in different structures analyzed, thus corroborating its medicinal use. In this way, we intend to continue the study evaluating whether in species from planting occurs production of the secondary metabolites identified in wild plants.

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Conflicts of interest

There are no conflicts of interest.

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