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Chemical composition of volatile compounds in flowers and leaves of *Senna reticulata* (Leguminosae) from the Eastern Amazonia

Composição química de compostos voláteis em flores e folhas de *Senna reticulata* (Leguminosae) da Amazônia Oriental

Composición química de compuestos volátiles en flores y hojas de *Senna reticulata* (Leguminosae) de la Amazonía Oriental

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Abstract

Senna reticulata (Willd.) H. S. Irwin & Barneby is a Leguminosae's family plant and native from Amazonia, as known as "matapasto" that means "killspasture" or "shaman's leaf", it is utilized as food, medicine, and other uses for the populations of the region. But to it has a lack of information about its constituents, as well as for several other species of plants from Amazonia. So, this research aimed to reveal the chemical composition of the aroma in flowers and leaves of *S. reticulata* from Eastern Amazonia. Because such information had not yet been presented for the species and may be useful for its better understanding. The aroma of the flowers was a predominance of Geraniol (30.28%), Citronellol (27.87%) and Methyl salicylate (12.91%). While in the leaves was characterized by a mixture of 2E-Hexenal (5.0%) + Hex-(3Z)-enol (67.82%), and by Methyl salicylate (9.81%) and para-vinylGuaiacol (6.14%).

The information presented here could contribute for the development of products, based on the chemical composition of the aroma in flowers and leaves from *S. reticulat*a, as well as for future research.
Keywords: Aroma; Biomolecules; Characterization; Shaman's leaf.

Resumo
Senna reticulata (Willd.) H. S. Irwin & Barneby é uma planta da família Leguminosae nativa da Amazônia, conhecida como "matapasto" ou "folha de pajé", é utilizada como alimento, medicinamento e outros usos pelas populações da região. Mas para ela faltam informações sobre seus constituintes, assim como sobre várias outras espécies de plantas amazônicas ainda pouco estudadas. Assim, esta pesquisa teve como objetivo revelar a composição química do aroma das flores e folhas de *S.* r*eticulata* na Amazônia Oriental. Porque tais informações ainda não haviam sido apresentadas para a espécie, e podem ser úteis para sua melhor compreensão. O aroma das flores houve predominância de Geraniol (30,28%), Citronelol (27,87%) e Salicilato de Metila (12,91%). Já o aroma das folhas foi caracterizado por uma mistura de 2E-Hexenal (5,0%) + Hex-(3Z)-enol (67,82%), e por Salicilato de Metila (9,81%) e para-vinilGuaiacol (6,14%). As informações aqui apresentadas poderão contribuir para o desenvolvimento de produtos, com base na composição química do aroma em flores e folhas de *S. reticulata*, bem como para futuras pesquisas.
Palavras-chave: Aroma; Biomoléculas; Caracterização; Folha de pajé.

Resumen
Senna reticulata (Willd.) H.S. Irwin & Barneby es una planta nativa de la Amazonia, conocida como "matapasto" u "hoja de chamán", es utilizada con fines alimentarios, medicinales y de otro tipo por las poblaciones de la región. Pero carece de información sobre sus componentes, así como sobre varias otras especies de plantas amazónicas que aún están poco estudiadas. Así, esta investigación tuvo como objetivo revelar la composición química del aroma de flores y hojas de *S. reticulata* en la Amazonía Oriental. Debido a que tal información aún no ha sido presentada para la especie, y puede ser útil para su mejor comprensión. El aroma de las flores, predominó Geraniol (30,28%), Citronelol (27,87%) y Salicilato de Metilo (12,91%). Em el las hojas se caracterizó por una mezcla de 2E-Hexenal (5,0%) + Hex-(3Z)-enol (67,82%), y por Salicilato de Metilo (9,81%) y para-vinil-guayacol (6,14%). La información aquí presentada podría contribuir para el desarrollo de productos, basados en la composición química del aroma en flores y hojas de *S. reticulata*, así como para futuras investigaciones.
Palabras clave: Aroma; Biomoléculas; Caracteriación; Hoja de chamán.

1. Introduction

The *Senna reticulata* (Willd.) H. S. Irwin & Barneby is a species of plant, native from the Amazonia, first described for Willdenow (1809) from Eastern Amazonia (Pará state), now occurring from Mexico to Bolivia (Souza, 2012; Tropicos, 2022). In Brazil, it is distributed throughout practically all the entire territory, except in the states of the Southern Region (Souza & Bortoluzzi, 2022; Silva et al., 2018). *Senna*'s species are also known in the Amazonia as "shaman's leaf" due their properties and uses in the traditional culture as food and healing plant (Rodrigues,1989; Trindade, 2021).

Due to its fast growth and easily adaptation to floodplains the *S. reticulata* is also considered a pioneer plant in the open areas of the Amazonia (Parolin, 2001; Souza, 2012), it grows in disturbed areas as pasture, so is also called of "matapasto" that means "kills pasture" by the population of the Amazonia (Falcão-da-Silva et al., 2016; Trindade et al., 2021). As well as recent studies indicated that *S. reticulata* could be a good and viable source of biofuel (Grandis et al. 2021). And *S. reticulata* is also used as an ornamental plant in the Amazonia (Di Stasi & Hiruma-Lima, 2002; Prance, 1975), it can be found in public places like streets and avenues, being cultivated or growing spontaneously in the region.

The use of vegetables as natural food as well as medicinal plants are viable alternatives for the treatment of various diseases (Kinupp & Lorenzi, 2014; Lorenzi & Matos, 2021). Are several records for the use of the *S. reticulata* in Amazonia's traditional medicine, mainly its use in skin diseases such as mycoses, rash, scabies and eczema, the parts generally used are the bark and leaves, but it is variety according to treatment, so pratically all parts of the plant are useful (Di Stasi & Hiruma-Lima, 2002; Neves et al. 2017). Including *S. reticulata* has scientific proof for antifungal, antimalarial and antioxidant properties (Macedo et al. 2016; Prata-Alonso et al. 2015; Santos et al. 2008).

However, for *S. reticulata* as well for several other plant species in the Amazonia, there is still a lack of studies to expand the knowledge of its properties and biological characteristics. So, the chemical composition of the volatile compounds

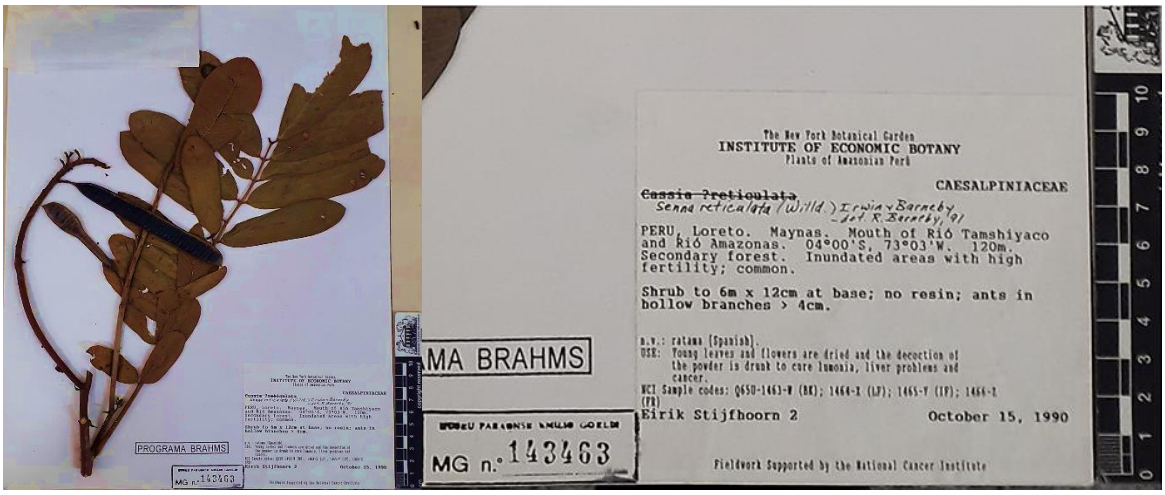
in flowers and leaves from *S. reticulata* in Oriental Amazonia is presented here.

2. Material and Methods

2.1 Choose of the species

It is important to emphasize that the choice of *S. reticulata* for this study was due to the properties attributed to this species by scientific literature (Neves et al., 2017; Prata-Alonso et al. 2015; Rodrigues, 1989; Souza, 2012; Trindade et al., 2021), and for its several records in the traditional medicine of the Amazon including has exsicates desposited in Herbarium (Figure 1) that refers the use of flowers and leaves from *S. reticulata* in the treatment of several diseases in the Amazonia.

Figure 1. Exsicate by *S. reticulata* (MG n° 143463). According to the description "young leaves and flowers area dried and the decoction of the powder is drunk to cure lumonia, liver problems and cancer" in Peru.



Source: Authors.

2.2 Botanical collection and identification

For this research botanical collections (Figure 2) and the identification of the species *S. reticulata* were realized according to traditional techniques in plant taxonomy (Martins-da-Silva et al., 2014), on 18 September 2019, in the Research Campus of Museu Paraense Emílio Goeldi, in the city Belém from the Pará state, Amazonia, Brazil, the geographic coordinates of 01°27'04" (S) and 48°26'47" (W). A sample was selected for registration and identified and incorporated as an exsicate in the in the Herbarium of the Museu Paraense Emílio Goeldi (MG) under the registration MG 233276.

Figure 2. Botanical collection of *S. reticulata*.

Source: Authors.

2.3 Obtaining volatile concentrate (aroma)

To chemical characterization of the aroma of flowers and leaves from *S. reticulata*, the methodology in this research is according with Zoghbi et al. (2000), that realized the characterization of the aroma in several species of Amazonia's plants, but with some changes when necessary. For this purpose, 8g of tissue samples from flowers and leaves of *S. reticulata* were used, submitted to simultaneous hydrodistillation-extraction (SDE) for 3 hours using a Chrompack system, and pentane (2ml) as solvent.

2.4 Analysis of the chemical composition of the aroma

The chemical compositions of the essential oils (EOs) of *S. reticulata*, were analyzed using a Shimadzu QP-2010 (Kyoto, Japan) plus gas chromatography (GC) system equipped with an Rtx-5MS capillary column (Restek Corporation, Bellefonte, USA) (30 m × 0.25 mm; 0.25 µm film thickness) coupled to a mass spectrometer (MS) (Shimadzu, Kyoto, Japan). The program temperature was maintained at 60–240 °C at a rate of 3 °C/min, with an injector temperature of 250 °C, helium as the carrier gas (linear velocity of 32 cm/s, measured at 100 °C) and a splitless injection (1 µL of a 2:1000 hexane solution) using the same operating conditions as described in the literature (Ferreira et al., 2020; Oliveira et al., 2020). Except for the carrier hydrogen gas, the components were quantified using GC on a Shimadzu QP-2010 system (Kyoto, Japan), equipped with a flame ionization detector (FID), under the same operating conditions as before. The retention index for all volatile constituents was calculated using a homologous series of n-alkanes (C8–C40) Sigma-Aldrich (San Luis, USA), according to Van Den Dool and Kratz (1963). The components were identified by comparison of the experimental mass spectra with those compiled in libraries and their retention indices to those found in the literature (Adams, 2007; Babushok et al., 2011).

3. Results and Discussion

Chemical composition of the aroma from the flowers and leaves of *S. reticulata*. Figures 1 and 2 shows the chromatogram ions for flowers and leaves of *S. reticulata*, and the 11 volatile compounds was detected in GC, the peaks observed in the figures are listed in Table 1.

Table 1. Volatile aroma compounds from the leaves and flowers of *S. reticulata* obtained by the simultaneous hydrodistillation-extraction process. RI(C): Retention index calculated. RI (L): Retention index found in the literature.

RI(C)	RI(L)	Constituints	Flowers (%)	Leaves (%)
794	788	1- Octene		3.44
845	846	2E-Hexenal (5.0) + Hex-(3Z)-enol (67.82)		72.82
856	863	n-Hexanol	6.18	
894	894	2-Heptanol	7.90	3.87
1099	1095	Linalool		0.54
1110	1112	Rose oxide	1.28	
1166	1165	Lavandulol	7.66	
1194	1190	Methyl salicylate	12.91	9.81
1227	1223	Citronellol	27.87	
1253	1249	Geraniol	30.28	1.68
1313	1309	*para*-vinylGuaiacol		6.14
		Oxygenated monoterpenes	67.09	0.54
		Phenylpropanoides	12.91	9.81
		Others class	14.8	86.27
		Total	94.8	96.62

Source: Authors.

The 11 compounds were identified through this research representing a total of (96.62%) in the leaves, and (94.8%) in the flowers. According to table 1, the aroma in the flowers was a predominance of Geraniol (30.28%), Citronellol (27.87%) and Methyl salicylate (12.91%). For the leaves was characterized by a mixture of 2E-Hexenal (5.0%) + Hex-(3Z)-enol

(67.82%), and by Methyl salicylate (9.81%) and para-vinylGuaiacol (6.14%). While the aromas of the flowers and leaves of *S. reticulata* presented a different chemical profile, with a content of (86.27%) of other classes of compounds in the leaves and (67.09%) of hydrocarbon monoterpenes in the flowers. This difference in chemical composition is associated with the different types of plant organs in the plant (Figueiredo et al., 2008).

Until then, there were no studies in the literature that reported the chemical composition of the aroma of flowers and leaves from *S. reticulata*, however studies with the essential oil of other Leguminosae species have demonstrated the strong presence of monoterpene compounds and other classes it, as described in the study by Gilardoni et al. (2020) with the essential oil from flowers of *Dalea mutisii* Kunth, which was characterized by α-pinene (42.9%), β-pinene (15.1%), β-phellandrene (12.6%), myrcene (6.7%) and (Z)-β-ocimene (5.4%). Major compounds: β-caryophyllene (15.9%), caryophyllene oxide (9.2%), α-humulene (8.1%), epi-γ-eudesmol (7.5%), α-bisabolol (4.7%), copaene (3.5%), nerolidol (3.3%), α-bisabolol oxide B (2.5%) and spathulenol (2.1%) characterized the chemical profile of the essential oils of *Bauhinia ungulata* L. (Medeiros et al., 2016).

The 2E-Hexenal is a volatile compound emitted by plants during some cutting process or stress caused. Furthermore, it is part of the so-called green leaf volatiles (GLVs), which play an important role in transferring information to plants and insects (Spyropoulou et al., 2017). This aldehyde belongs to one of the valuable flavors, as it contributes to the fresh odor of vegetables and fruits, as well as being widely used in flavors, perfumes and fragrances (Xiong et al., 2012). This compound is described in the literature because it has antifungal and antibacterial properties with potential to inhibit fungi such as: *Colletotrichum coccodes* and *Helminthosporium solani*, and bacteria like as *Pectobacterium atrosepticum* (Wood et al., 2013).

And the Methyl salicylate is a phenolic compound that, by nature, has the function of defending the plant against attacks from pathogens and herbivores, thus, it is speculated that this compound is a good volatile for use in pest management, because its presence does not affect cultivars of plants (Mallinger et al., 2011). This major compound had a higher content in the aroma of flowers (12.91%) compared to leaves (9.81%), is described in the literature as having antimicrobial action, against fungi and bacteria (Ament et al., 2010; Nikolić et al., 2013), and repellents insects as *Bemisia tabaci* (Pérez-Hedo et al., 2018). The compound para-vinylGuaiacol is reported in the literature for presenting antioxidant and antibacterial properties (Pripdeevech & Saansoomchai, 2013).

Geraniol the major component of flowers, is a colourless to light yellow monoterpene that is found in several vegetables such as geraniums (*Geranium* sp.), roses (*Rosa* sp.) and others (Tiwari & Kakkar, 2009). This constituent is used in the cosmetics industry as an additive in fragrances or as the essence of several products. This compound has records in the literature that attest to being an antimicrobial, antioxidant, anti-inflammatory, neuroprotective agent and shows therapeutic and preventive effects in different types of cancer (Chen & Viljoen, 2010; Cho et al., 2016; Medeiros et al. 2018).

Citronellol had a very significant content in flowers (27.87%), which has antifungal, antibacterial, anti-tumor, anti-inflammatory, antinociceptive and insecticide properties, being a promising agent in the development of natural repellents (Pereira et al., 2015). Lavanduol only characterized the chemical profile of the aroma of flowers with a content of (7.66%), which nature this compound can be found in small levels in essential oils, and its purpose transcends its application in perfumes, as in the habitat of plants they exert the pheromone function for some species of insects (Ciołak, 2014). The compound 2-Heptanol characterized the chemical profile of both leaves and flowers, and in flowers (7.90%) it was higher than in leaves (3.87%), this constituent has repellency activity against insects as like the *Tribolium castaneum* (Ukeh & Umoetok, 2011).

4. Final Thoughts

Extraction by hydrodistillation proved to be adequate and efficient to obtain aroma of flowers and leaves from *S.*

reticulata. The analysis of volatile compounds by GC/MS allowed the identification of 11 substances. In the flowers was a predominance of Geraniol (30.28%), Citronellol (27.87%) and Methyl salicylate (12.91%). While the leaves characterized by a mixture of 2E-Hexenal (5.0%) + Hex-(3Z)-enol (67.82%), and by Methyl salicylate (9.81%) and para-vinylGuaiacol (6.14%).

The data presented improve understand of the Amazonia's biodiversity, due *S. reticulata* shows several uses for humans and is aim of constantly interactions with insects and other beings. And the information presented here could contribute for the development of products, based on the chemical composition of aroma in flowers and leaves of *S. reticulata*. It also opens possibilities for other studies from this elucidated composition.

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