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Artículos originales

## Potential ethnobotanical relevance of *Lycianthes sanctaeclarae* (Greenm.) D`Arcy (Solanaceae): A review

Potencial relevancia etnobotánica de *Lycianthes sanctaeclarae* (Greenm.) D`Arcy (Solanaceae): Una revisión

Marta Porras-Navarro<sup>1</sup>  0000-0001-5626-1005

German Madrigal-Redondo<sup>1</sup>  0000-0002-9856-4044

Tania Arias-Altamirano<sup>1</sup>  0000-0001-8190-9707

Audry Escudero-Correa<sup>1</sup>  0009-0006-4655-5951

<sup>1</sup>Universidad de Costa Rica, Facultad de Farmacia, Instituto de Investigaciones Farmacéuticas (INIFAR), San José, Costa Rica.

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### Correspondence

Marta Porras Navarro  
marta.porras@ucr.ac.cr

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### Conflict of interests

The authors have not reported a conflict of interest.

## Resumen

**Introducción:** La familia de las Solanáceas es una de las familias de angiospermas más importantes desde el punto de vista económico. Con cerca de 100 géneros y 3.000 especies, incluye importantes plantas alimenticias, condimentarias y medicinales. Uno de los tres géneros más variados y extensos de las solanáceas es *Lycianthes*. *Lycianthes sanctaeclarae* (Greenm.) D'Arcy, es una especie nativa de Costa Rica, Nicaragua y Panamá, que se encuentra en la selva tropical a una altitud de 0 a 600 metros sobre el nivel del mar.

**Objetivo:** El propósito de esta investigación es obtener información sobre la especie *Lycianthes sanctaeclarae* para la determinación del potencial etnobotánico de dicha especie, mediante una revisión bibliográfica de bases de datos.

**Método:** Se realizó una revisión bibliográfica y un análisis de las posibles aplicaciones etnobotánicas, las actividades biológicas y la constitución química de la familia de las solanáceas, concretamente de *Lycianthes sanctaeclarae*.

**Resultados:** Las solanáceas tienen importancia florística, etnobotánica, ornamental, ritual, económica y médica. Incluyen una gran variedad de fitoquímicos entre los que destacan los alcaloides, con propiedades biológicas interesantes, siendo la actividad anticolinérgica la más investigada.

**Conclusiones:** Se determinó la falta de información que existe sobre la especie *Lycianthes sanctaeclarae*. Aun así, por su relación con la familia de las solanáceas, es posible considerar que esta especie podría ser una opción llamativa para el desarrollo de nuevos fármacos; sin embargo, es necesario en un futuro identificar, aislar, purificar y caracterizar los compuestos bioactivos que posee esta especie mediante la construcción de su perfil fitoquímico.

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**Palabras clave:** Etnobotánica; *Lycianthes sanctaeclarae*; Plantas medicinales; Solanaceae.

## Abstract

**Introduction:** The Solanaceae family is one of the most important families of angiosperms from an economic point of view. With nearly 100 genera and 3,000 species, it includes important food, condiment, and medicinal plants. One of the three most varied and extensive genera of Solanaceae is *Lycianthes*. *Lycianthes sanctaeclarae* (Greenm.) D'Arcy, is a species native to Costa Rica, Nicaragua, and Panama, which is found in the rainforest at an altitude of 0 to 600 meters above sea level.

**Objective:** The purpose of this research is to obtain information about the species *Lycianthes sanctaeclarae* for the determination of the ethnobotanical potential of said species, through a bibliographic database review.

**Method:** A bibliographic review and an analysis of the possible ethnobotanical applications, biological activities, and chemical constitution of the Solanaceae family, specifically *Lycianthes sanctaeclarae*, were conducted.

**Results:** Solanaceae has floristic, ethnobotanical, ornamental, ritual, economic, and medical importance. They include a wide variety of phytochemicals, among which alkaloids stand out, with interesting biological properties, with anticholinergic activity being the most investigated.

**Conclusions:** The lack of information that exists on the species *Lycianthes sanctaeclarae* was determined. Even so, due to its relationship with the Solanaceae family, it is possible to consider that this species could be a striking option for the development of new drugs; However, it is necessary in the future to identify, isolate, purify, and characterize the bioactive compounds that this species has by constructing its phytochemical profile.

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**Keywords:** Ethnobotany; *Lycianthes sanctaeclarae*; Medicinal plants; Solanaceae.

## Highlights

The Solanaceae family is one of the most economically important families of angiosperms. One of the three most varied and largest genera of the Solanaceae is *Lycianthes*, also commonly known as “Ajcillo,” “Barba de Tigre,” “Childa,” “Huevo de Sapo,” and “Nicua”. *Lycianthes sanctaeclarae* (Grenm.) D`Arcy, is a native species of Costa Rica, Nicaragua and Panamá, found in the rainforest, which could have ethnobotany potential.

The main contribution of this review has been to determine the lack of information and research that exists on the species *Lycianthes sanctaeclarae*.

Therefore, this review could be the basis for future research, guided by phytochemical tests, to identify different bioactive compounds this species possesses. So, it can be a striking option for the development of new drugs.

## Introduction

The Solanaceae family, known informally as the “bewitching herbs,” is one of the most economically important families of angiosperms, after Poaceae and Fabaceae. The Solanaceae family is also one of the largest in the plant kingdom, with nearly 100 genera and 3,000 species, and includes important food, spice, and medicinal plants. Approximately 50% of the species can be included in the genus *Solanum*, which is considered very diverse morphologically, including species such as potato (*S. tuberosum*), tomato (*Solanum lycopersicum*), eggplant (*S. melongena*), pepper (*Capsicum annuum*), among others. In addition, other plants such as tobacco (*Nicotiana* sp.), *Withania somnifera*, *Petunia* sp., *Datura innoxia*, *Atropa belladonna*, and *Lycianthes* sp. have well-known medicinal properties<sup>(1,2,3,4)</sup>.

It is usually distributed in tropical and temperate districts; it is concentrated in regions such as Latin America, Mexico, Europe, and Australia. In Europe, for example, they have been characterized by their anticholinergic properties; that is, they block cholinergic action in the central and peripheral nervous system by binding the alkaloids to muscarinic receptors. Among the best-known alkaloids are scopolamine, hyoscyamine, and atropine, and they play a significant role in health by influencing the cardiovascular, nervous, and respiratory systems and have been used over centuries as intoxicants, poisons, medicines, rituals, and cultural inspirations, among others<sup>(2,3)</sup>.

In regions like Mexico, the Solanaceae family ranks fourteen among the most diverse angiosperms in the country; it is estimated that approximately 34 genera and 407 of the total species grow. One of the three most varied and largest genera of the Solanaceae is *Lycianthes*, after *Solanum* and *L.* and *Cestrum* *L.* Its greatest diversity is centered in America; for example, 39 species grow in Mexico. The genus *Lycianthes*, also commonly known as “Ajcillo,” “Barba de Tigre,” “Childa,” “Huevo de Sapo,” and “Nicua.” Was (separated from *Solanum* by Hassler in 1917), then in 1919 Bitter made the first monograph of the genus, and about 150 species were included, to date about 200 species distributed in tropical regions of Asia and America have been recorded<sup>(5,6,7,8)</sup>.

This genus is of Neotropical affinity, distinguished by its 0-10 toothed calyx (five calyx lobes are truncated into a sleeve-shaped rim and protrude below the calyx rim) and its anthers with apical porical dehiscence. In addition, it has calculus cells in the fruits, axillary inflorescences. Some authors affirm that there is a morphological affinity between *Lycianthes* and *Capsicum* due to the calyx. Of *Lycianthes*, 187 taxa have been identified, including 152 species, ten subspecies, and 25 varieties native to Asia-Pacific and America<sup>(5,9,10,11)</sup>.

*Lycianthes* life forms include vines, trees, shrubs, lianas, and herbs. Most of the species are vines or shrubs, and a minor part is herbs; some examples are *L. acapulcensis*, *L. hintonii*, *L. moziniana*, *L. peduncularis*, *L. ciliolata*, *L. rzedowskii*, *L. starbuckii* and *L. dejecta*, which are true herbs, which annually arise and die back to tuberous roots. Other species have green primary stems when young but become shrubs or trees with time, eg *Lycianthes heteroclita*, *L. geminiflora*, and *L. ceratocalycia*. Others, like *L. stephanocalyx*, depending on the climate, can remain grassy or become woody. Other species are considered short shrubs, for example, *Lycianthes amatitlanensis*, *L. glabripetala*, and *L. inconspicua*<sup>(11)</sup>.

Some species are often confused, for example, *L. heteroclita*, *L. nitida* and *L. sanctaeclarae* are often confused with *L. synanthera*. But they can be delimited, *Lycianthes sanctaeclarae* is the only one that presents sinuous anticline walls on the adaxial surface, while the others have curved walls. In addition, *L. nitida* and *L. sanctaeclarae* have flat-convex petioles, while *L. synanthera* has a winged petiole. On the other hand, *L. heteroclita* has a biconvex petiole with projections towards the adaxial surface. And the only one that has two central vascular bundles in the petiole is *L. heteroclita*<sup>(12)</sup>.

*Lycianthes sanctaeclarae*, a native species of Costa Rica, Nicaragua y Panamá, is found in the rainforest at an elevation of 0 to 600 meters above sea level. This shrub has alternate, simple leaves with pubescence; it has asymmetric petioles at the base of the leaf, a light green underside with pubescence, and a soft green upper surface with little pubescence. In addition, it has flowers that are pollinated by bees at the base of the purple petioles, with lanceolate-shaped petals with a white margin, light green calyx, and white stamens. It can be seen in Image 1<sup>(13,14)</sup>.

In relation to taxonomy, it can be said that this species belongs to:

Kingdom: Plantae

Phylum: Tracheophyta

Class: Magnoliopsida

Order: Solanales

Family: Solanaceae

Genus: *Lycianthes* (Dunal) Hassl.

Species: *Lycianthes sanctaeclarae* (Greenm.) D'Arcy

In addition, this species is native to Costa Rica, Nicaragua and Panama. And a record of its presence has been found in other American countries, such as Brazil, Argentina, Paraguay, and Uruguay. In the following image you can see its distribution map<sup>(15)</sup>.



**Image 1.** Distribution map of *L. sanctaeclarae*.<sup>(15)</sup>

In the following photograph taken on November 22, 2022, you can clearly see the green leaves, yellow fruits and purple flowers of the species *L. sanctaeclarae*. It was found in San Carlos, in the province of Alajuela, Costa Rica. At an altitude of 343.4 meters above sea level.



**Image 2.** *Lycianthes sanctaeclarae* located in San Carlos, Alajuela Province. Original photo, taken November 22, 2022.

## Methods

A bibliographical review and an analysis of the potential ethnobotanical applications, biological activities, and chemical constitution of the Solanaceae family, specifically *Lycianthes sanctaeclarae*, were conducted. The main objective was to obtain information on this species. The databases consulted in the search process were SIBDI, ScienceDirect, SpringerLink, and Google Scholar, and the languages consulted were English and Spanish using the following terms and keywords: Solanaceae, nightmare, ethnobotany, *Lycianthes sanctaeclarae*, biological activities, chemical constitution. The eligibility criteria for the consulted material included original and review articles that described information on the different characteristics of the Solanaceae family. In the Google Scholar database, using the keywords “Solanaceae” and “biological activities”, 12 results and only 5 articles were used. Likewise, using the keywords “*lycianthes*” and “chemical constitution”, 15 results and only 6 were found. Furthermore, with the keywords “nightmare” and “ethnobotany”, 7 results were found, and only 3 articles were used. Also, with the keyword “*Lycianthes sanctaeclarae*”, 3 results were found, but only 1 article was used.

In the ScienceDirect database, using the keywords “*Lychiantes*” and “chemical constitution” were found 10 results and only 5 were used. In the SpringerLink database, using the keywords “Solanaceae” and “ethnobotanical applications” 7 results were found and only 3 were used. In SIBDI database, using the keywords “biological activities” and “*Lycianthes*”, 8 results were found and only 2 articles were used.

## Results and Discussion

### Ethnobotanical applications

Ethnobotany corresponds to the study of the relationship between plants and man; it is usually defined as the scientific study of the knowledge and traditional customs of peoples concerning plants and their medical, religious, history, and beliefs. Normally all this knowledge is acquired to satisfy the needs of human beings, such as hunger, cure ailments, heal wounds, using forests as a source of food, medicines, etc. Solanaceae, also known as ‘Nightshades’, are associated with floristic, ethnobotanical, ornamental, ritual, and economic importance. Humans widely use its different species as a source of food, spices, and medicines<sup>(16,17)</sup>.

Regarding food, potatoes, tomatoes, peppers and eggplants are part of the most important commercial crops, along with other species of the Solanaceae genera such as *Withania*, *Capsicum* ad *Hyoscyamus*.

On the other hand, *Atropa*, and *Nicotiana*, are some of those that helped in the early stages of the discovery of various drugs that are based on medicinal plants and that are still considered very important in herbal practice<sup>(18)</sup>.

Some assert that this family grows on almost every continent except Antarctica. They are rich in alkaloids, often used in traditional medicinal systems, and homeopathy. They stand out for their use as insecticides, anti-infectives, antimicrobials, and poisons. Some secondary metabolites associated with its ethnobotanical properties are alkaloids, flavonoids, AMP, glycosides, lignans, phenols, lactones, steroids, terpenoids, and sugars. For example, AMPs in plants help protect them from pests so that they could be used in the future for their anti-infective potential<sup>(18)</sup>.

Some pharmacological studies have been carried out to validate and verify the applications of traditional medicines of plants belonging to the *Lycianthes* genus. Activities such as antiplasmodial, anti-protozoal, anthelmintic, antianemic, antiallergic, antihistamine, antihypertensive, analgesic, antibacterial, anticonvulsant, antiasthmatic, antidiabetic, antiurolithiatic, anticarcinogenic, antileishmanial, antimelanogenetic, antidepressant, antidiabetic, antifungal, hepatoprotective, antimolluscicidal, antinociceptive, anti-psoriatic, antitrypanosomal, antiviral, cardiovascular, diuretic, anti-inflammatory, hypolipidemic, mosquito larvicidal, nephrotoxic, spasmolytic, schistosomicidal and vasorelaxant activities<sup>(19)</sup>.

*Lycianthes* species have different ethnopharmacological uses, the fruits of *L. ciliolata*, *L. moziniana* and *L. peduncularis* have been associated with religious ceremonies; for example, they are offered to the spirits on the day of the dead. In addition, the use of *L. moziniana* as food, medicine, and offering has been recorded. On the other hand, known for their traditional applications are the fruits of *L. acapulcensis* and *L. rzedowskii*<sup>(5)</sup>.

Other species, such as *Lycianthes synanthera*, are used in traditional cooking for dishes of ethnic groups. For example, in Guatemala, the Q’eqchi ethnic group living in Alta Verapaz prepares the traditional dish “Chomte” with *L. synanthera* as an ingredient, with tomato, onion, salt and vegetable oil<sup>(20)</sup>.

### Biological activities

Of the 405 families of angiosperms, the Solanaceae corresponds to a diversified family of plants that includes a great variety of healthy chemical components and a wide range of alkaloids, with anticholinergics being the most investigated. Likewise, nightshades, in addition to having an important medicinal value, also have great economic value and have provided important ornamental and food plants to humanity. Some species of certain genera that belong to the Solanaceae family have anticancer properties; among these are: *Solanum*, *Capsicum*, *Atropa*, *Nicotiana*, *Datura*, and *Withania*, among others. In addition, nightshades are a source of a wide range of phytochemicals responsible for some pharmacological properties such as anti-inflammatory, antiasthmatic, anticancer, antihyperglycemic, antiaging, antimicrobial, antispasmodic, antitussive, antidiabetic, and hepatoprotective. Another property of the different species of Solanaceae is their anti-malarial activity, for which abundant steroidal compounds such as alkaloids, saponins, and steroidal lactones were identified as responsible. In ad-

dition, other compounds such as phenolics, terpenes, and lipids have also been involved in medicinal purposes<sup>(1,9,22,23,24,25)</sup>.

Likewise, these same species of some genera, such as *Datura*, are also used as an antiepileptic, antiparkinsonian, antitussive, antifungal, antirheumatic, anthelmintic, an antidote in cases of cholinesterase poisoning, and as a medicine against facial neuralgia, earaches, and headaches. In addition, regarding the antibacterial activity of this genus, some in vitro studies indicate that the extracts of *D. innoxia* and *D. stramonium* may have an action against some Gram+ bacteria, *Staphylococcus aureus*, *Klebsiella pneumoniae*, and some strains of *Vibrio cholera* and *V. parahaemolyticus*. Anticancer effects of the *Datura metel* species against human epidermal carcinoma have also been reported, and the presence of withanolides in *D. metel* seeds has been shown to have potential immunosuppressive effects and antiproliferative activity against human gastric adenocarcinoma. In addition, the cytotoxic activity of *Datura lanose* on carcinomas such as breast, colon, and lung has been studied<sup>(26)</sup>.

On the other hand, there is the genus *Solanum*, which is the richest in edible species, including tomatoes (*Solanum lycopersicum*), eggplants (*Solanum melongena*), and potatoes (*Solanum tuberosum*). In this species, a glycoalkaloid called solanine has been found, which has demonstrated in vitro antitumor activity against stomach carcinoma (SGC-7901, hepatocellular carcinoma (HepG2, the most sensitive culture) and colon cell culture (LS174) by stimulating apoptosis in a dose-dependent manner. In addition, the antimetastatic potential of saline by inhibiting MMP-2 has been studied. And MMP-9 was associated with the suppression of migration and invasion of the A2058 human melanoma cell line. Solanidine derivatives are able to arrest the G0/G1 and G2/M phases of the cell cycle. On the other hand, synthetic solanidine analogs prepared from pregnenolone acetate have been shown to have antiproliferative activity against cultured HL-60 human leukemia cells. In addition, other species of Solanaceae have also shown antitumor activity against various types of cancer, including breast, prostate, and colon cancer<sup>(21,26)</sup>.

**Table 1:** Summary of biological activities studied for *Lycianthes* species.

Species	Studied biological activities	Reference
<i>L. rantonnetii</i>	Antioxidant	(2)
<i>L. synanthera</i>	Antibacterial, antifungal and cytotoxic. Also has antinutritional factors (hemagglutinin activity), trypsin and $\alpha$ -amylase inhibiting activity.	(28,29)
<i>L. lycioides</i> (L.) Hassl.	Antinociceptive and antibacterial	(17,30)

As previously mentioned, the Solanaceae family groups a great variety of genera that are of medicinal interest due to their properties; among these, some of the species that comprise the genus *Lycianthes* will be studied in detail in table 1. Like *L. rantonnetii*, which has been shown to have a high content of antioxidant vitamins and a significant amount of total phenol and flavonoids, it was determined that the plant has a high free radical scavenging activity. Thanks to this property, its use as an additive in food products has been evaluated in various sectors with appropriate antioxidant activities<sup>(2)</sup>.

The leaves of the species *Lycianthes panthera*, a vegetable known as home, have a high content of Ca, Zn, K, Cu, Fe, ascorbic acid, crude protein, carbohydrates, riboflavin, and energy. Therefore, being a rich source of nutrients, it will have a high potential to reduce nutrient and energy deficiencies. It has been proposed that pregnant or lactating women could benefit from eating *L. synanthera* leaves due to their high Ca, Fe and riboflavin content. However, this nutritional value is reduced due to the presence of hemagglutinins (lectins) and  $\alpha$ -amylase and trypsin inhibitors, which can limit the optimal use of some of the nutrients by the body. This limitation can be treated and even eliminated by employing treatments such as traditional 15-min boiling, resulting in a decrease in lectins and  $\alpha$ -amylase inhibitory activity<sup>(20)</sup>.

Likewise, in an investigation where several Solanaceae species were studied, it was found that the strongest antimicrobial activity of all the examined species was obtained with *Solanum deflexiflorum*, followed by *L. synanthera* and *Solanum leucocarpum*. This study showed that the Solanaceae plant spe-

cies tested possess antifungal, antibacterial, and cytotoxic activities against the organisms examined. Another species of the genus *Lycianthes* that has been studied is *L. lycioides* (L.) Hassl, it has antinociceptive and antibacterial activity due to its alkaloid content<sup>(17,28,29)</sup>.

### Chemical constitution

Solanaceae plants produce abundant secondary metabolites with interesting biological properties, of which its high alkaloid content stands out. These alkaloids can influence the cardiovascular, nervous, and respiratory systems; for this reason, they have been invaluable for humans over time. In addition, they possess other compounds that can benefit human health, such as phenolic compounds, saponins, lipids, and terpenes. In particular, toxic alkaloids such as glycoalkaloids or tropane alkaloids are particularly interesting for their antioxidant, antimicrobial, and antirheumatic activities. Likewise, numerous studies have shown that the Solanaceae family contains alkaloids such as tomatine, solasodine, solanine, desacetoxysolafilididine,  $\beta$ -solamarin, and 2a-hydroxysoladulcidin, which have antinociceptive and antibacterial properties against gram-negative and gram-positive bacteria<sup>(17,21,22,25)</sup>.

The chemical components of different species of Solanaceae and *Lycianthes* are detailed in two tables (Table 2 and 3). It is also important to clarify that phytochemical information on the species *Lycianthes sanctaeclarae* is not included because no national or international information on this species was found.

For this reason, it is considered relevant to carry out the corresponding phytochemical studies of this species.

**Table 2:** Summary of some species of Solanaceae and their chemical constituents.

Species	Chemical constituents	Reference
<i>Acnistus arborescens</i> (L.) Schlttdl	Alkaloids (withanolide, with physalis, aconitine), glycosides, organic acids, tannins, and saponins.	(21)
<i>Hyoscyamus albus</i>	Saponins, flavonoids, terpenes, alkaloids, tannins, cardiac glycosides, and alkaloids (tropinone, hygrine, tropine, pseudotropine, 3 $\beta$ -acetoxytropine, 3a-acetoxytropine, cuscohygrine, apoatropine, littorine, scopolamine, hyoscyamine, and 6 $\beta$ -hydroxyhyoscyamine).	(21)
<i>Nicotiana glauca</i>	Alkaloids, diterpenes, flavonoids, cardiac glycosides, and metals.	(21, 27)
<i>Nicotiana tabacum</i>	Contains glycosides (tabacinin, tabacin), 2-methylquinone, 2-naphthylamine, propionic acid, nicotelin, nicotianine, 2, 3, 6-trimethyl-1, 4-naphthoquinone, cembrene, antalin, choline, pyrene, and anethole	(21, 27)
<i>Datura innoxia</i>	Essential oils, flavonoids saponins, phenols, (+)-catechin and (-)-epicatechin, heneicosanoic acid, cardiac glycosides, atropine, scopolamine, methyl (Z)-5, 11, 14, 17-eicosatetraenoate, 11, 14, 17-eicosatrienoic acid.	(21)
<i>Datura metel</i>	Dmetelins A–D, withafastuosins A–C, and E, withanolides, withamtelin and baimantuoluoline A–C	(21)
<i>Datura stramonium</i>	Alkaloids (atropine, apoatropine, tigloidin, hyoscyamine, aposcopolamine, scopolamine N-oxide, 6aditiglioyloxytropine, hyoscyamine N-oxide, and 7-hydroxyhyoscyamine), saponins, flavonoids, tannins, steroids, glycosides, phenols, and terpenoids.	(21)
<i>Lycium barbarum</i>	Flavonoids, minerals, vitamins, alkaloids, polyphenols, polysaccharides (LBP), phenolic compounds, and di caffeoyl spermine/spermidines	(21, 31, 32)
<i>Lycium shawii</i> Roem. and Schult.	Alkaloids (piperidine, nortropine, spermine, tropane, imidazole, cyclopentapyrrolidine, pyrrole), flavonoids, ceramides, peptides, anthraquinones, coumarins, terpenoids (mono, di, and triterpenes), cinnamic acid amides, lignans, carotenoids, lignanamides, and neolignanamides	(21)



**Table 3:** Summary of some *Lycianthes* species and their chemical constituents

Species	Chemical constituents	Reference
<i>Lycianthes rantonnetii</i>	Contains: Cu, Mg, Zn, Co, P, Fe, Mn, Sr, Cr, Ti, V, Mo, Pb, Cd, As, Li, Tl, and Be. Also has significant content of vitamins A, C, and E retinol, additionally it contains ascorbic acid, tocopherol, flavonoids and phenols, these last two would be responsible for their compounds were responsible for the highest rates of antioxidant activity.	(2)
<i>Lycianthes synanthera</i>	Contains: Fe and Cu and high levels of oxalates.	(20, 33)

## Conclusion

This review has determined the lack of information that exists regarding Costa Rican, Nicaragua and Panamá native species *Lycianthes sanctaeclarae*. However, due to its relationship with the Solanaceae family and to the ethnobotanical properties described in this article, it is possible to consider these findings can be the basis for future research, guided by phytochemical tests, that allow identifying the different bioactive compounds that these species possess, and thus associate them to potential biological activities.

These species could be a striking option for the development of new drugs. However, it is necessary in the future to identify, isolate, purify, and characterize the bioactive compounds these species possess by constructing their phytochemical profile.

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