

Cnidoscopus aconitifolius: therapeutic use and phytochemical properties. Literature review

Cnidoscopus aconitifolius: usos terapéuticos y propiedades fitoquímicas. Revisión de la literatura

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Abstract

Introduction: Medicinal plants have been traditionally used to cure or alleviate infectious and non-infectious diseases. They are widely accepted due to their low cost and low toxicity indexes. These plants are frequently used in cases involving skin irritation, superficial wounds, insect bites, and snake bites.

Objective: To compile available evidence on the main therapeutic uses and phytochemical components of *Cnidoscopus aconitifolius* (popularly known as chaya), a plant that grows in tropical regions of Mexico and Central America.

Materials and methods: A literature review of studies on *C. aconitifolius* published until 2017 was conducted in the BIREME, PubMed/Medline, Elsevier and SciELO databases. Descriptors "*Cnidoscopus*" and "*aconitifolius*" were used for the literature search, and no language restrictions were applied.

Results: 82 articles were retrieved after completing the initial search. Once the studies were filtered by title (descriptors in the title) and duplicates were removed, 18 articles were reviewed. Based on the information found, it was possible to confirm that this plant has multiple health benefits.

Conclusions: The traditional therapeutic use of *Cnidoscopus aconitifolius* is backed by scientific evidence. Therefore, further research aimed at identifying new phytochemical properties of this plant should be conducted to establish alternative therapies for treating different conditions.

Keywords: Plants, Medicinal; Phytochemicals; Therapeutic Uses (MeSH).

Resumen

Introducción. El uso tradicional de plantas medicinales para tratar diferentes enfermedades, ya sean infecciosas o no, es ampliamente aceptado debido a su bajo costo y sus bajos índices de toxicidad. Estas plantas son frecuentemente usadas en casos que involucran irritaciones de la piel, heridas superficiales, picaduras de insectos y mordeduras de víboras.

Objetivo. Recopilar la información disponible sobre los principales usos terapéuticos y los componentes fitoquímicos de *Cnidoscopus aconitifolius*, una planta conocida popularmente como chaya y que crece en regiones tropicales de México y Centroamérica.

Materiales y métodos. Se realizó una revisión de la literatura sobre *C. aconitifolius* publicada hasta 2017 en las bases de datos BIREME, PubMed/Medline, Elsevier y SciELO. Para la búsqueda se emplearon los descriptores "*Cnidoscopus*" y "*aconitifolius*", y no se aplicaron filtros de idioma.

Resultados. Se identificaron 82 artículos luego de completar la búsqueda inicial. Después de filtrar los estudios por título (presencia de descriptores de búsqueda en el título) y remover duplicados, se incluyeron 18 artículos en la revisión. De acuerdo a la información encontrada, fue posible confirmar que esta planta ofrece diversos beneficios para la salud.

Conclusiones. El uso terapéutico tradicional de la chaya está sustentado por evidencia científica, por lo que se sugiere realizar más investigaciones centradas en la identificación de nuevas propiedades fitoquímicas de esta planta y, así, establecer alternativas terapéuticas para distintas afecciones.

Palabras clave: Plantas medicinales; Fitoquímicos; Usos terapéuticos (DeCS).

Bautista-Robles V, Guerrero-Reyes G, Sánchez-Torres GI, Parada-Luna FJ, Barrios-Gutiérrez JJ, Vázquez-Cerero D, et al. *Cnidoscopus aconitifolius*: therapeutic use and phytochemical properties. Literature review. Rev. Fac. Med. 2020;68(3):446-52. English. doi: <http://dx.doi.org/10.15446/revfacmed.v68n3.75184>.

Bautista-Robles V, Guerrero-Reyes G, Sánchez-Torres GI, Parada-Luna FJ, Barrios-Gutiérrez JJ, Vázquez-Cerero D, et al. [*Cnidoscopus aconitifolius*: usos terapéuticos y propiedades fitoquímicas. Revisión de la literatura]. Rev. Fac. Med. 2020;68(3):446-52. English. doi: <http://dx.doi.org/10.15446/revfacmed.v68n3.75184>.

Introduction

About 80% of people living in developing countries practice traditional medicine as an alternative therapy for their health care. Specifically, the use of medicinal plants in therapy (defined as any plant species that can be used for therapeutic purposes due to its composition or whose active ingredients can serve as precursors for the synthesis of new drugs), also known as phytotherapy, is quite widespread worldwide. It is worth noting that around 67% of the species used in these types of therapies come from least developed and developing countries.¹⁻⁶

Traditional medicine is based on folk knowledge, which determines its efficacy through observable benefits. This type of medication may pose challenges; for example, in popular phytotherapy, it is very difficult to control the dose and quality of the product, which can lead to risks and damage to health. This problem is mainly explained by the fact that many traditional remedies are made from wild plants whose chemical components can vary due to genetic or environmental reasons.^{7,8} It should be noted that ethnobotany has no scientific validation.⁹⁻¹⁰

The traditional use of medicinal plants to treat both infectious and non-infectious diseases has been widely accepted since ancient times due to their low cost, accessibility, and low toxicity rates compared to synthetic products.¹¹⁻¹³ Humans commonly resort to this therapeutic option in the presence of skin irritations, wounds, insect bites, and snake bites.^{14,15}

Currently, there is an exponential increase in the use of phytotherapy to maintain an adequate state of general health.¹⁶ In this regard, the World Health Organization (WHO) states that more than two thirds of the world's population use or have used at least one medicinal plant to treat some condition.⁴

Chronic non-communicable diseases are a new challenge in the fight to improve global health and are a public health concern despite the progress made by the pharmaceutical industry. Moreover, it should be noted that some populations do not have easy access to medicines and medicinal plants are their first, or even only, treatment option.

In this context, a relevant example of the use of phytotherapy is *chaya* (*Cnidoscolus aconitifolius*), a plant of the genus *Cnidoscolus* that belongs to the family *Euphorbiaceae*, which has been attributed different benefits for the treatment and control of certain pathologies. The family *Euphorbiaceae* comprises 50 species, of which 20 are considered endemic to Mexico and are distributed mainly in tropical and subtropical zones, Mesoamerica being the area where they are most produced and where their domestication is most frequent.¹⁷⁻¹⁹

Hypoglycemic,²⁰ antioxidant,²¹ analgesic and anti-inflammatory effects²²⁻²⁴ are the main benefits attributed to *chaya*. It is commonly used to treat rheumatism, gastrointestinal disorders²⁵ and inflammatory diseases,^{26,27} and it has also been reported that it has an important nutritional contribution as poultry feed, especially in Africa.²⁸ In recent years, to measure its efficacy and safety, various investigations have analyzed the components of this plant, the leaves being the most studied part.^{29,30}

The objective of this research was to review the available literature on the main medical uses and phytochemical components of *C. aconitifolius* to answer the question:

Is there sufficient scientific evidence on the therapeutic properties of *chaya* to treat human pathologies?

Materials and methods

A literature review on *C. aconitifolius* was conducted in the BIREME, PubMed/Medline, Elsevier and SciELO databases with the descriptors "*Cnidoscolus*" and "*aconitifolius*". The search was limited to articles published until 2017; no articles were excluded because of language restrictions or methodological reasons.

Data search

The first step was to make a general query without restrictions, and then a new search was made using the title as a filter. The strategies presented in Table 1 were applied.

Table 1. Databases analyzed and search strategies used.

Database	Search strategy (syntax)	Search limits	No. of articles
Elsevier	TITLE(<i>Cnidoscolus aconitifolius</i>)	Title	3
SciELO	(ti:(<i>cnidoscolus</i>)) AND (ti:(<i>aconitifolius</i>))	Titulo	1
BIREME	(ti:(<i>Cnidoscolus aconitifolius</i>))	Titulo	15
PubMed/Medline	<i>Cnidoscolus</i> [Title] AND <i>aconitifolius</i> [Title]	Title	14

Source: Own elaboration.

Selection of articles

In the first search without restriction, 82 articles were retrieved. During the subsequent search, after filtering the publications by title, 33 were obtained, of which 15 were excluded because they were repeated. Finally, 18 articles were included in the research. The algorithm for selecting the articles of interest is shown in Figure 1.

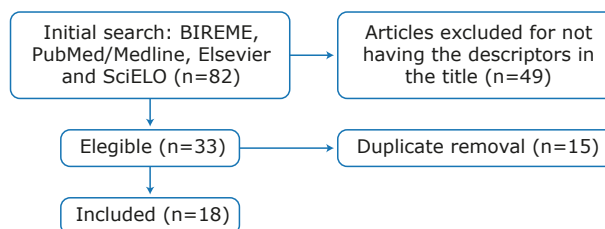


Figure 1. Flow chart used for selection of the articles of interest. Source: Own elaboration.

Data collection

The selected articles were reviewed to synthesize, analyze, and facilitate the understanding of the results. The relevant data of each study were summarized in two groups: main phytochemical constituents of *C. aconitifolius* and medicinal properties of *C. aconitifolius*.

Captured photographs

During the study, some photographs of *C. aconitifolius* were taken (Figure 2) to complement the study with visual

material. The pictures were taken using a Sony DSC-H400/VC E33 digital camera on January 21, 2018, in the community of Santo Tomás Tamazulapam (district of Miahuatlán

de Porfirio Díaz, state of Oaxaca, Mexico), which is located in the following coordinates: latitude: 16.2705 and longitude: -96.5874 16° 16' 14" North, 96° 35' 15" West.



Figure 2. Photographs of *Cnidoscolus aconitifolius*. A) flower buds and plant flowers; B) lamina, primary and secondary veins, and petiole; C) stem; D) canopy. Source: Documents obtained during the study.

Results

Thirty-three research articles were included and classified according to the year of publication as shown in

Figure 3. The largest number of articles about *C. aconitifolius* were published in 2010 and 2016 (8 each year).

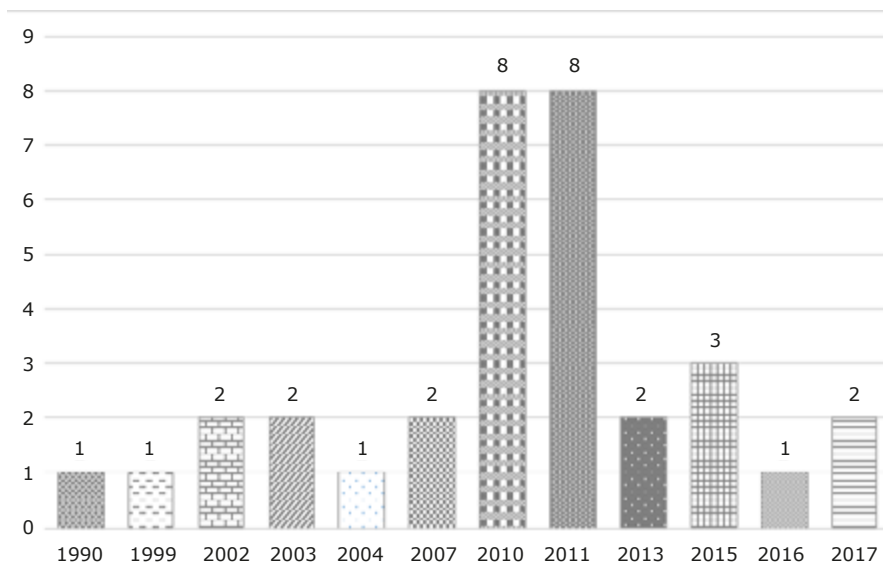


Figure 3. Number of publications on *Cnidoscolus aconitifolius*. The arrow indicates the year of publication of the first study found on this plant. Source: Own elaboration.

By refining the articles and eliminating duplicates, a final sample of 18 articles was obtained with which the final analysis of the data was carried out. The publications

were organized according to the main phytochemical constituents (Table 2) and the medicinal properties of *C. aconitifolius* (Table 3).

Table 2. Main phytochemical constituents of *Cnidoscolus aconitifolius*.

Authors Year	Type of study	Part of the plant studied	Phytochemical constituents
Donkoh <i>et al.</i> ²⁸ 1990	Phytochemical study of the dry leaf	Leaves	High dietary protein potential for animals and toxic hydrocyanic glycosides that are degraded by cooking.
Sarmiento-Franco <i>et al.</i> ²⁹ 2003	Phytochemical study	Leaves	Raw fiber (140 g/kg), protein (305 g/kg), calcium (15.3 g/kg) and seven amino acids: alanine, arginine, aspartic acid, glutamic acid, leucine, isoleucine, and phenylalanine.
Escalante-Erosa <i>et al.</i> ³⁰ 2004	Epicuticular wax study	Tall leaves	Three triterpenoids: amirenone, β -amyirin acetate, and α -amyirin acetate.
Numa <i>et al.</i> ³¹ 2015	Phytochemical study	Leaves	Flavonoids (hispidulin sulfate, eucalyptin and epigallocatechin di-O-gallate), sesquiterpene (triptofordin D1), xanthones (moreolic acid), polyanxanthone c, cadensin g, arvixanthone d and lignan (tiegusanin f).
Oyagbemi <i>et al.</i> ³² 2011	Phytochemical screening	Leaves	Flavonoids, alkaloids, saponins, tannins, magnesium, manganese, iron, potassium, phosphate, and zinc.
Adaramoye <i>et al.</i> ³³ 2011	Clinical study on protection from liver damage	Leaves	Tannins, alkaloids, saponins, anthraquinones, flavonoids, cardiac glycosides, and phlobatannins.
Jaramillo-Jaramillo <i>et al.</i> ³⁴ 2015	Phytochemical study	Leaves of adult flowering plants	Fatty acids, triterpenes, and sugars.
Jiménez-Aguilar <i>et al.</i> ³⁵ 2015	Phytochemical study	Dry leaves	Calcium, magnesium, potassium, phosphorus, sulfur, iron, sodium, vitamin C (more abundant than in other green plants), as well as phenolic compounds at high levels, and flavonoids at medium levels.
Morales-Alvarado <i>et al.</i> ³⁶ 2016	Phytochemical study	Dehydrated leaves	Cyanogenic glycosides precursors of hydrocyanic acid, although it was proved to be easily eliminated by heat treatment.
Awoyinka <i>et al.</i> ³⁷ 2007	Phytochemical study	Dry leaves	Alkaloids, tannins, phlobatannins, saponins, and cardiac glycosides.

Source: Own elaboration.

Table 3. Medical properties of *Cnidoscolus aconitifolius*.

Authors Year	Medicinal potential of the plant described	Animal model	Study element	Main efficacy results
Azeez <i>et al.</i> ¹⁹ 2010.	Antioxidant effect	25 male Wistar rats weighing from 100 to 250 grams	Leaves	<i>C. aconitifolius</i> improved the hematological parameters of alloxan-induced diabetes.
Saba <i>et al.</i> ²² 2010	Hepatoprotective and antioxidant effect	30 male Wistar rats weighing from 220 to 250 grams	Leaves	<i>C. aconitifolius</i> showed a significant restoration of hematological parameters and a decrease in blood ureic nitrogen and creatinine levels.
Oyagbemi <i>et al.</i> ²³ 2010	Hepatoprotective effect against paracetamol damage	25 healthy male Wistar rats weighing from 220 to 250 grams	Leaf extract obtained from ethanol	<i>C. aconitifolius</i> had a hepatoprotective effect against paracetamol.
Onasanwo <i>et al.</i> ²⁴ 2011	Analgesic and anti-inflammatory effect	30 Sprague-Dawley rats/mice weighing from 140 to 160 grams.	Leaves	<i>C. aconitifolius</i> demonstrated significant anti-inflammatory and analgesic effects.
Adaramoye <i>et al.</i> ³³ 2011	Stimulation of insulin secretion	6-week old male Wistar rats weighing from 170 to 180 grams	Leaves	<i>C. aconitifolius</i> showed hepatoprotective and antioxidant effects, as well as protection against ethanol-induced poisoning.
Jaramillo-Jaramillo <i>et al.</i> ³⁴ 2015	Antioxidant effect	Male Wistar rats	Leaves	<i>C. aconitifolius</i> had an antioxidant effect but not a hypoglycemic effect.

Table 3. Medical properties of *Cnidoscolus aconitifolius*. (continued)

Authors Year	Medicinal potential of the plant described	Animal model	Study element	Main efficacy results
Sarmiento-Franco <i>et al.</i> ³⁸ 2002	Fattening effect on corn-fed chickens	Two-week old Hubbard chickens and day-old Ross chickens	Leaf flour	<i>C. aconitifolius</i> improved fattening of chickens on low-protein diets.
Oladeinde <i>et al.</i> ³⁹ 2007	Hypoglycemic effect	4-8-week-old male mice weighing 25 grams	Leaves	<i>C. aconitifolius</i> stimulated dormant β cells to secrete insulin.
Adaramoye & Aluko ⁴⁰ 2011	Nephro-protective effect of methanol extract against chronic ethanol exposure.	42 male Wistar rats weighing from 170 to 180 grams	Leaf extract obtained from ethanol	<i>C. aconitifolius</i> had a nephroprotective effect against chronic ethanol exposure and reduced glucose, protein, gamma-glutamyltransferase, and creatinine clearance levels.
Achi <i>et al.</i> ⁴¹ 2017	Hypoglycemic, anticholesterolemic and antihypertriglyceridemic effect.	Albino and healthy male rats weighing 120 to 130 grams	Leaves	<i>C. aconitifolius</i> reduced blood glucose levels, increased weight and serum insulin level, and had a hypoglycemic, antihypercholesterolemic, insulin modulating and antihypertriglyceridemic action.

Source: Own elaboration.

Discussion

According to the available evidence, there are several investigations on *C. aconitifolius*^{19,22-24,28-41} that confirm that its use as a medicinal plant has some benefits in the treatment of several diseases or injuries^{42,43}. Therefore, further studies on the phytochemical properties and possible therapeutic uses of this plant should be conducted to identify new therapeutic alternatives for the treatment of different conditions^{24,37}, which will undoubtedly improve the quality of life of communities where traditional medicine is the main form of medical therapy.

Aguilar *et al.*⁴⁴ state that *C. aconitifolius*, besides having medicinal properties, is used as a vegetable and as fodder, which coincides with what is reported by Ross-Ibarra & Molina-Cruz.⁴⁵ Furthermore, according to Parra-Tabla *et al.*,⁴⁶ this plant can be consumed at any time as long as it has not lost more than 50% of its leaves, which depends on the type of climate in which it develops.

Some studies^{22,23,33,40} describe the benefits of *C. aconitifolius* to treat hepatotoxicity and hematotoxicity since the plant components help reduce toxicity. Likewise, other works^{39,43} have shown that chaya plays a key role in reducing high glucose levels in animal models.

It is worth mentioning that the results also show that *C. aconitifolius* has antioxidant^{19,34,35} and antimicrobial^{37,47} properties due to its secondary metabolites (flavonoids, tannins, saponins,³⁰⁻³² etc.).^{48,49} Similarly, it was found that this plant contains phenolic components, which are the most abundant group of non-energy substances in foods of plant origin.⁵⁰

Other species in the genus *Cnidoscolus* also show health benefits.^{42,43} For example, Poot-López *et al.*⁵¹ reported the diuretic and hypoglycemic effects of *Cnidoscolus chayamansa*. During this review, we also found that Donkoh *et al.*⁵² suggested the inclusion of chaya in the food industry as a potential ingredient for poultry diet. In the study by Saba *et al.*²² on the effects of *C. aconitifolius* leaf extract in rats with liver damage induced by carbon tetrachloride, it was found that the

compounds of the plant restore the levels of hematological parameters, blood ureic nitrogen, and creatinine. Finally, Oyagbemi *et al.*,²³ in an analysis of the anti-diabetic properties of ethanolic extract of chaya made in male Wistar rats with alloxan-induced diabetes mellitus, showed that *C. aconitifolius* extract significantly reduces blood glucose and plasma cholesterol levels.

Conclusions

C. aconitifolius is a plant species that has a significant protein content and is rich in flavonoids, tannins, and saponins. These characteristics grant it hypoglycemic, hepatoprotective, nephroprotective, anti-inflammatory and antioxidant properties.

The safety and efficacy of the traditional therapeutic use of chaya is supported by scientific evidence. Therefore, further research should be carried out focusing on the identification of new phytochemical properties of this plant and, thus, establish therapeutic alternatives for different conditions.

Conflicts of interest

None stated by the authors.

Funding

None stated by the authors.

Acknowledgements

To the Postgraduate Studies Division of the Universidad de la Sierra Sur for their support for the preparation of this review.

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