Cnidoscolus aconitifolius: therapeutic use and phytochemical properties. Literature review

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

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 Cnidoscolus 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 “Cnidoscolus” 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 Cnidoscolus 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 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 Cnidoscolus 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 descriptor “Cnidoscolus” 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 descriptor 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).


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.9–12 It should be noted that ethnobotany has no scientific validation.9–12

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 mostly 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 disorders17 and inflammatory diseases26,27 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.

<table>
<thead>
<tr>
<th>Database</th>
<th>Search strategy (syntax)</th>
<th>Search limits</th>
<th>No. of articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elsevier</td>
<td>TITLE(Cnidoscolus aconitifolius)</td>
<td>Title</td>
<td>3</td>
</tr>
<tr>
<td>SciELO</td>
<td>(ti:(cnicoscolus)) AND (ti:(aconitifolius))</td>
<td>Titulo</td>
<td>1</td>
</tr>
<tr>
<td>BIREME</td>
<td>(ti:(Cnidoscolus aconitifolius))</td>
<td>Titulo</td>
<td>15</td>
</tr>
<tr>
<td>PubMed/ Medline</td>
<td>Cnidoscolus[Title] AND aconitifolius[Title]</td>
<td>Title</td>
<td>14</td>
</tr>
</tbody>
</table>

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.

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
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*.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Type of study</th>
<th>Part of the plant studied</th>
<th>Phytochemical constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donkoh <em>et al.</em></td>
<td>1990</td>
<td>Phytochemical study of the dry leaf</td>
<td>Leaves</td>
<td>High dietary protein potential for animals and toxic hydrocyanic glycosides that are degraded by cooking.</td>
</tr>
<tr>
<td>Sarmiento-Francisco <em>et al.</em></td>
<td>2003</td>
<td>Phytochemical study</td>
<td>Leaves</td>
<td>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.</td>
</tr>
<tr>
<td>Escalante-Erosa <em>et al.</em></td>
<td>2004</td>
<td>Epicuticular wax study</td>
<td>Tall leaves</td>
<td>Three triterpenoids: amirenone, β-amyrin acetate, and α-amyrin acetate.</td>
</tr>
<tr>
<td>Numa <em>et al.</em></td>
<td>2015</td>
<td>Phytochemical study</td>
<td>Leaves</td>
<td>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).</td>
</tr>
<tr>
<td>Oyagbemi <em>et al.</em></td>
<td>2011</td>
<td>Phytochemical screening</td>
<td>Leaves</td>
<td>Flavonoids, alkaloids, saponins, tannins, magnesium, manganese, iron, potassium, phosphate, and zinc.</td>
</tr>
<tr>
<td>Adaramoye <em>et al.</em></td>
<td>2011</td>
<td>Clinical study on protection from liver damage</td>
<td>Leaves</td>
<td>Tannins, alkaloids, saponins, anthraquinones, flavonoids, cardiac glycosides, and phlobatannins.</td>
</tr>
<tr>
<td>Jaramillo-Jaramillo <em>et al.</em></td>
<td>2015</td>
<td>Phytochemical study</td>
<td>Leaves of adult flowering plants</td>
<td>Fatty acids, triterpenes, and sugars.</td>
</tr>
<tr>
<td>Jiménez-Aguilar <em>et al.</em></td>
<td>2015</td>
<td>Phytochemical study</td>
<td>Dry leaves</td>
<td>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.</td>
</tr>
<tr>
<td>Morales-Alvarado <em>et al.</em></td>
<td>2016</td>
<td>Phytochemical study</td>
<td>Dehydrated leaves</td>
<td>Cyanogenic glycosides precursors of hydrocyanic acid, although it was proved to be easily eliminated by heat treatment.</td>
</tr>
<tr>
<td>Awoyinka <em>et al.</em></td>
<td>2007</td>
<td>Phytochemical study</td>
<td>Dry leaves</td>
<td>Alkaloids, tannins, phlobatannins, saponins, and cardiac glycosides.</td>
</tr>
</tbody>
</table>

Source: Own elaboration.

Table 3. Medical properties of *Cnidoscolus aconitifolius*.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Medicinal potential of the plant described</th>
<th>Animal model</th>
<th>Study element</th>
<th>Main efficacy results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azeez <em>et al.</em></td>
<td>2010</td>
<td>Antioxidant effect</td>
<td>25 male Wistar rats weighing from 100 to 250 grams</td>
<td>Leaves</td>
<td><em>C. aconitifolius</em> improved the hematological parameters of alloxan-induced diabetes.</td>
</tr>
<tr>
<td>Saba <em>et al.</em></td>
<td>2010</td>
<td>Hepatoprotective and antioxidant effect</td>
<td>30 male Wistar rats weighing from 220 to 250 grams</td>
<td>Leaves</td>
<td><em>C. aconitifolius</em> showed a significant restoration of hematological parameters and a decrease in blood ureic nitrogen and creatinine levels.</td>
</tr>
<tr>
<td>Oyagbemi <em>et al.</em></td>
<td>2010</td>
<td>Hepatoprotective effect against paracetamol damage</td>
<td>25 healthy male Wistar rats weighing from 220 to 250 grams</td>
<td>Leaf extract obtained from ethanol</td>
<td><em>C. aconitifolius</em> had a hepatoprotective effect against paracetamol.</td>
</tr>
<tr>
<td>Onasanwo <em>et al.</em></td>
<td>2011</td>
<td>Analgesic and anti-inflammatory effect</td>
<td>30 Sprague-Dawley rats/mice weighing from 140 to 160 grams</td>
<td>Leaves</td>
<td><em>C. aconitifolius</em> demonstrated significant anti-inflammatory and analgesic effects.</td>
</tr>
<tr>
<td>Adaramoye <em>et al.</em></td>
<td>2011</td>
<td>Stimulation of insulin secretion</td>
<td>6-week old male Wistar rats weighing from 170 to 180 grams</td>
<td>Leaves</td>
<td><em>C. aconitifolius</em> showed hepatoprotective and antioxidant effects, as well as protection against ethanol-induced poisoning.</td>
</tr>
<tr>
<td>Jaramillo-Jaramilloet <em>et al.</em></td>
<td>2015</td>
<td>Antioxidant effect</td>
<td>Male Wistar rats</td>
<td>Leaves</td>
<td><em>C. aconitifolius</em> had an antioxidant effect but not a hypoglycemic effect.</td>
</tr>
</tbody>
</table>
Table 3. Medical properties of Cnidoscolus aconitifolius. (continued)

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

Source: Own elaboration.

Discussion

According to the available evidence, there are several investigations on C. aconitifolius that confirm that its use as a medicinal plant has some benefits in the treatment of several diseases or injuries. 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, which will undoubtedly improve the quality of life of communities where traditional medicine is the main form of medical therapy.

Agular et al. state that C. aconitifolius, besides having medicinal properties, is used as a vegetable and as fodder, which coincides with what is reported by Ross-ıbara & Molina-Cruz. Furthermore, according to Parra-Tabla et al., 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 describe the benefits of C. aconitifolius to treat hepatotoxicity and hematotoxicity since the plant components help reduce toxicity. Likewise, other works 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 and antimicrobial properties due to its secondary metabolites (flavonoids, tannins, saponins, etc.). 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.

Other species in the genus Cnidoscolus also show health benefits. For example, Poot-López et al. reported the diuretic and hypoglycemic effects of Cnidoscolus chayamansa. During this review, we also found that Donkoh et al. suggested the inclusion of chaya in the food industry as a potential ingredient for poultry diet. In the study by Saba et al. 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 urea nitrogen, and creatinine. Finally, Oyagbemi et al. 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.

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