

***BERBERIS RIGIDIFOLIA* KUNTH. (BERBERIDACEAE) COLOMBIAN ENDEMIC PLANT.**

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Abstract

Berberis rigidifolia is a plant commonly known as espino, espuelo, espino de oro and tachuelo in Colombia. *Berberis rigidifolia* is known for various medicinal properties in traditional medicinal and use to cure a variety of diseases. The plant is reported to treat amebiasis, diarrhea, uterine bleeding, mouth irritations, sore throats, laxative, cutaneous leishmaniasis, malaria, pyorrhea, blood pressure, laxative and external ulcers. The medicinal properties of this plant represent it as a valuable source of medicinal compounds. This work is collective information concerning the taxonomy, ecology, geographical distribution, altitude distribution, ethnobotany, phytochemistry, biological activities and toxicity of the *Berberis rigidifolia*.

Key words: *Berberis rigidifolia*, ethnobotany, phytochemical, medicinal plant, Colombia.

Introduction

Berberis rigidifolia is an exclusive plant from Colombia, of ample endemic distribution in the Departments of Boyacá, Cundinamarca and Norte de Santander. It presents a high isoquinoline alkaloid content, of which berberine is the most abundant [1]. It has been used in therapies against amebiasis, malaria, and as an antibacterial and antiprotozoal agent [2]. Moreover, for skin complications it can be used as an astringent or to treat external ulcers [3] or cutaneous leishmaniasis [1]. In addition, it has been reported in ailments against uterine atony or uterine hemorrhage. For digestive problems it can be used to treat diarrhea [3] and gastroenteritis, as a tonic, as a bile secretion stimulant, to treat hepatoses, as a purgative or laxative. It can reduce blood pressure [2] and as a febrifuge. Furthermore, in the mouth cavity it has been employed for mouth and throat irritations, swellings of the gums, and against pyorrhea. Other uses include to treat rheumatic syndrome [3]. In the laboratory its phototoxic activity in Chinese hamster ovary cells has been demonstrated [4].

Methods

The methods utilized to search, gather and analyze information include the following Data Banks: Plantlist, Scopus, PubMed, SIB Bioinformatics Resource Portal, and Sinab. Books and articles referring *Berberis rigidifolia* ethnobotanical aspects or any subject related to taxonomy or phytochemistry were included. In addition, books and articles describing biological activity medicinal properties and toxicity among others were also employed.

Taxonomy

The plant belongs to the Plantae kingdom, Division: Magnoliophyta, Class: Magnoliopsida, Order: Ranunculales, Family: Berberidaceae, Genus: *Berberis*, Species: *Berberis rigidifolia*. It is a two meter shrub, with abundant mucronate small leaves each 1.5 - 2 cm long, 5 - 6 mm wide. *Berberis rigidifolia* has short dark yellow spines, terminal flowers, short yellow peduncles, and light yellow flowers [5]. In addition it has terete black subverruculosum glabrous stems. 3-fld spines, 2 - 6 mm long. Obovate elliptic leaves 3-5 x 1-1.8 cm with a cuneate base, subsessile, apex obtuse, entire margins or serrate 1 mm margins or towards the apex 3-7-spiny (2 - 2.5 mm), distinctly 3 - 6 mm. The leaf blade is glossy green with indistinct finely open reticulate-veins. The back of the leaf has an elevated open reticulate-vein, at first slightly

pruinose and gray, ending with a paler green. Flowers are arranged as a raceme of 10 to 15 flowers 4 to 6 cm long. Glabrous pediceles 6 - 10 mm, 2 - 3 mm bracts. Inner sepals 6 x 4.5 mm. Petals 5 x 4.5 mm [6]. The National Colombian Herbarium has classified this species under voucher COL 569371.

Geographical distribution

Berberis rigidifolia is a plant exclusively found in Colombia, of ample endemic distribution. According to specimens deposited in the Colombian (COL) National herbarium it is distributed in Colombia in the cities of Bogotá and the Departments of Boyacá, Cundinamarca and Norte de Santander. In the Surroundings of Bogotá it is found in La Calera, Guasca, Tenjo and Zipaquirá [7]. García pointed out this species has been collected in the Department of Cundinamarca in the Bogotá Massif in the vicinities of Bogotá in the municipality of Tenjo in the Department of Cundinamarca [5]. Other authors describe this plant is found in the Andes mountains close to Bogotá, and cool places in the Eastern Cordillera. In addition it can be found at high altitudes in Quindío, Túquerres, Santa Rosa de Osos, and San Pedro [8, 9].

Altitudinal distribution

According to specimens deposited in the COL herbarium *Berberis rigidifolia* grows between 1.750 and 3.060 masl. García *et al.* described this species is found between 2.630 and 3.000 masl [5].

Ecology

According to specimens deposited in the COL herbarium *Berberis rigidifolia* is found in the Andean and sub-Andean forest. This species is native of cold altitudinal zone and moorland. It is abundant in cold weather and mountainous lands [7, 9].

Traditional use

Berberis rigidifolia berries can be eaten raw, employed to make cakes, or prepare fruit preserves. In addition to its culinary use it is a medicinal plant [7]. In the region of La Calera (Cundinamarca, Colombia) this species is abundant and habitants attribute beneficial properties for external ulcer treatment as well as uterine hemorrhages [8]. As described by White (1976) the roots of this plant are employed for treating hepatitis and as a laxative. Berries are also used as laxatives, and as refreshing. The root bark contains an alkaloid stimulating bile secretion, thus it has been indicated for various liver problems. It also can dilate blood vessels, lowering blood pressure. A teaspoon of the root or the berries

are used as laxatives. Furthermore, the berries are also used as a general tonic, since they work as mild laxatives and improve the digestive process. For external use berries or the root bark can be cooked to prepare a mouth wash, and gargles can be made with this tea to aid in mouth and throat irritations. Furthermore, it has been stated fresh fruit juice can strengthen the gums and relieve pyorrhea (pus flow from the gums) when it is directly applied. For a long time its roots have been used as a yellow dye for dyeing cotton and wool. To prepare a tea half a teaspoon or a teaspoon of root bark is placed with one cup of water. It is briefly boiled, and then cooled for five minutes. The tea can be drunk once or twice a day. From the dye three to seven drops can be taken with water, three or four times per day [10]. The prepared tea as previously described dilates blood vessels and reduces blood pressure. A dye prepared in a 10 g dose or as a 1 to 2 g extract are used to treat fevers [9].

Phytochemistry

Mezey described *Berberis rigidifolia* medicinal properties, reporting treated dried pulverized bark possess an alkaloid known as berberine. This isoquinoline alkaloid has a melting point of 145°C and is present as yellow crystals that slowly dissolve in water in an alkaline reaction. It can form ammonium quaternary salts by replacing the –OH group. It can form adducts with chloroform, acetone and benzene [11]. In her thesis Hartmann described *Berberis rigidifolia* to be richer in berberine compared with *Berberis officinalis*. In addition, this alkaloid is not only found in the root but in the stem bark, with yields of 6.6% and 1.4% respectively. Hartman determined the content of berberine as sulphate, and arrived at the conclusion this species only contained berberine sulphate [1]. In contrast, Professor Maximiliano Ordóñez Chemist from the Universidad Nacional de Colombia in 1966 performed various chemical assays from *Berberis rigidifolia* fruits and was unable to detect alkaloids [7]. In 1976 Rivera completed a preliminary phytochemical study with material collected from the national Forest park of La Calera, Cundinamarca 2.800 – 3.000 masl, identifying alkaloids in the stem, leaves and roots [8], described as berberine, oxyacanthine and hydrastine, Figure 1 [12]. Aristizábal and collaborators carried out a new study of the alkaloids present in the bark and wood of the stem, in the root (bark and wood), finding five minor alkaloids not yet identified. Berberine was determined through physical constants, chemical reactions, and stereoscopic evaluations to

help identify its structure [3]. Other studies indicate *Berberis rigidifolia* contains in its stems and particularly in its roots berberine and oxyacanthine; tannins and saponins in the aerial parts of the plant [8, 13]. Table 1 depicts total alkaloid content for *Berberis rigidifolia* and other species.

Medicinal properties

Name of the vegetative drug: *Berberis rigidifolia* Kunth, fructus (Colombian barberry), cortex, radix [14]. Berberine isolated from this species is recommended for cutaneous leishmaniasis treatment and for uterine hemorrhages. Hartmann found berberine present in the bark of the root or stem of this species has marked medicinal properties and can be used as an antileishmanial in the form of an ointment [1]. Berberine presents diverse biological activities such as a broad antibacterial, antiprotozoal agent, and even to reduce blood pressure among others [2]. Interest in the study of the *Berberis* genus arose from aboriginal utilization for treating ulcers, diarrheas and rheumatic syndrome [3]. Among the diverse biological activities it is useful in treating cutaneous ailments, amebiasis, or gastroenteritis. It has even been proposed useful in fighting malaria, yet without experimental conclusive results. It is known for its toxic action against *Aedes atropalpu*. Laboratory assays have demonstrated its phototoxic activity against Chinese hamster ovary (CHO) cells [4]. Berberine and hydrastine have well documented pharmacological properties used in modern clinical medicine as astringents and for membrane inflammations [15].

Toxicity

Phototoxic studies carried out in CHO cells with berberine sulphate and with *Berberis rigidifolia* ethanol extract demonstrated both compounds to be cytotoxic in the dark. Ethanol extract was found to be more phototoxic. Furthermore, under UV light exposure berberine generates an oxygen singlet, explaining its phototoxicity. Again the ethanol extract was found to be more photoactive [4]. Acute toxicity testing through LD₅₀ for berberine sulphate and berberine chloride was evaluated in golden hamsters with topic applications and subcutaneously, respectively. Only berberine chloride evidenced a LD₅₀ of 640 mg/kg with a hypoglycemic action and depression of the central nervous system [16].

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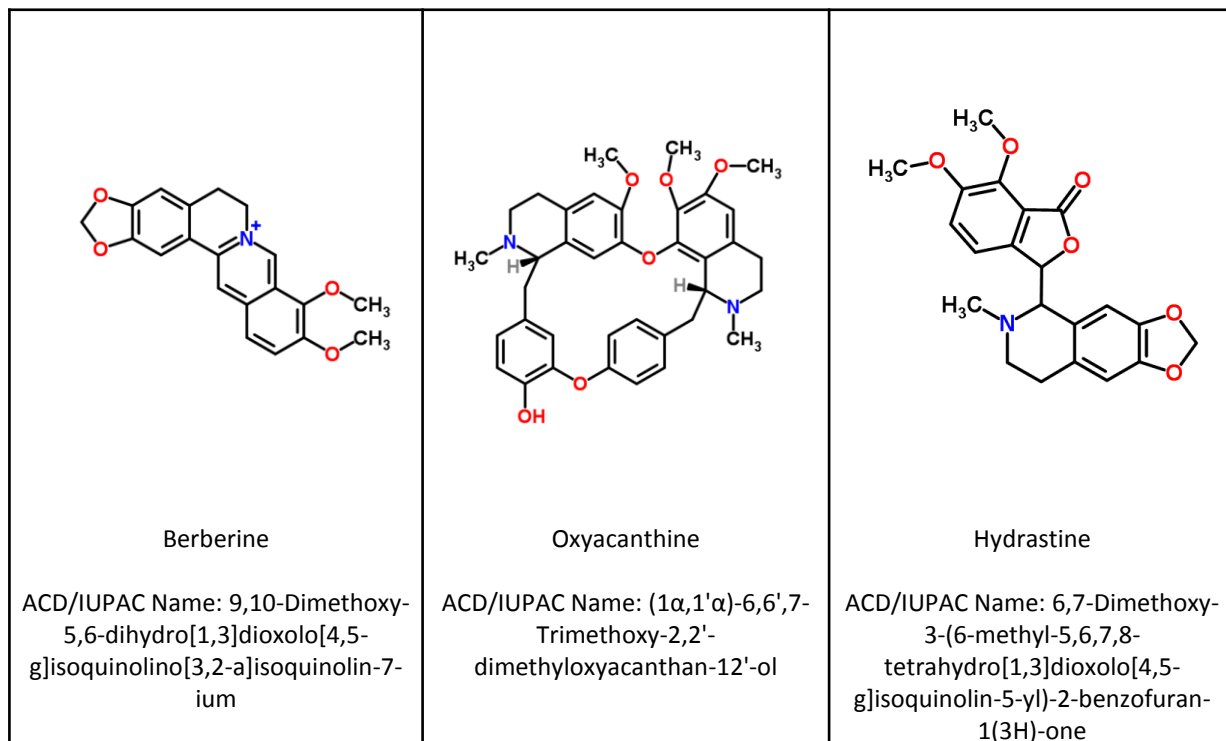


Figure 1. Compounds from *Berberis rigidifolia*

Table 1. Berberine content in *Berberis rigidifolia* and other species of the same genus (3)

Specie	Source	Stem underground (%)	Aerial stem, cortex (%)	Aerial stem, wood (%)
<i>Berberis rigidifolia</i>	Colombia	Cortex 17.5, wood 3.7	10.8, 14.0	5.9
<i>Berberis glauca</i>	Colombia	10.0	-	-
<i>Berberis huertasii</i>	Colombia	8.5	-	-
<i>Berberis chocontana</i>	Colombia	4.0	-	-
<i>Berberis oblonga</i>	Chile	Cortex 2.0, wood 0.8	-	-
<i>Berberis buxifolia</i>	Chile	0.7	-	-
<i>Berberis petiolaris</i>	Pakistán	0.43	-	-
<i>Berberis lycium</i>	Pakistán	1.2-1.4	-	-
<i>Berberis jaeschkeana</i>	Pakistán	1.6	-	-
<i>Berberis vulgaris</i>	Europa	15.3	7.9	-