Pluchea carolinensis (Jacq.) G. Don

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Pluchea carolinensis (Jacq.) G. Don.
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Abstract *Pluchea carolinensis*, is widely distributed in Central America, the Caribbean, the North of South America, and is naturalized in Florida, Hawaii, Islands of the Pacific, and Taiwan. The large number of common names given to *P. carolinensis* indicates the popularity of this medicinal plant. Also, the conformity in traditional uses between Spanish, French and English speaking cultures is remarkable. However, until now very few biological, pharmacological experiment are carried out to corroborate the traditional uses. Clinical experiments are completely absent. The anti-Leishmania activity of the extracts and pure compounds are promising.

Keywords *Pluchea carolinensis* · Traditional uses · Chemical compounds · Anti-Leishmania activity

1 Taxonomic Characteristics

Synonyms (Basionym), based on Tropicos: *Conyza carolinensis* Jacq.

The genus Pluchea consists of about 80 species distributed in tropical areas in North and South America, the Caribbean, Africa, Asia and Australia (Sharma and Goyal 2011). There has been some indistinctness about the nomenclature of *P. carolinensis*. The first confusion concerns the application of the name *Pluchea odorata* (L.) Cass (Godfrey 1952, in Villaseñor and Villareal 2006). In many publications, this name is used as a synonym for *P. carolinensis*. In 1977, William T. Gillis published a revision of this genus and concluded that *P. carolinensis* should be named as *Pluchea symphytifolia* (with *Conyza symphytifolia* as basionym) (Gillis 1977). Twelve years later Khan and Jarvis (1989) repeated the work of Gilles and concluded that the interpretation of the original material associated with the name *Conyza symphytifolia* was erroneous. They reestablished the former name, *P. carolinensis* (Jacq.) G.Don (with *Conyza carolinensis* as basionym) as the correct one. In this monograph, publications which use the name *P. symphytifolia* will be considered as *P. carolinensis* (Villaseñor and Villareal 2006; José Luis Villaseñor, pers. communication, April, 2011). The difference between *P. odorata* and *P. carolinensis* is quite obvious. The latter is a shrub, 1–2.5 m tall with big leaves, which are longer than wide. On the contrary, *P. odorata* is an herb, 40–90 cm tall and has small leaves. Publications with a clear taxonomic description of the plant, which permits to differentiate between the two species, are included in this study.

2 Common Names

In the Spanish speaking Caribbean, *P. carolinensis* is known as *salvia* (Dominican Republic, Liogier 1990, 1996, 2000; Cordero 1986; Mañon et al. 1992; Gupta 1995; Puerto Rico, Nuñez 1992; Alvarado-Guzmán et al. 2009; Gupta 1995; Cuba,

Escandón and Méndez 2006; Hernández and Volpato 2004; Beyra et al. 2004; Hammer et al. 1990; Garcia et al. 2010; Gupta 1995; Roig and Mesa 1928, Roig and Mesa 1965; Florida (USA), Hodges and Bennett 2006; Nicaragua, Gupta 1995; Barrett 1994; Panama, Gupta 1995; Venezuela, Gupta 1995). The popularity of this plant is indicated by the presence of quite some detailed names like: *Sauge rouge* (Haíti, Beauvoir et al. 2001 in Duke et al. 2009), *la sauge* (Haíti, Liogier 1990, 1996, 2000), *salvia*, *salvia blanca* (Dominican Republic, Liogier 1990, 1996, 2000; Cordero 1986), *salvia cimarron* (Cuba, Pino et al. 2009; Gupta 1995; Roig and Mesa 1928, 1965), *salvia de las Antillas* (Dominican Republic, Cordero 1986), *salvia de playa* Cuba, Barreto et al. 2002, 2007; Fuentes et al. 1989; Godínez and Volpato 2008; Pino et al. 2005, 2009; Milanés et al. 1999; Pérez et al. 2007; Rosales et al. 1999; Gupta 1995; Roig and Mesa 1928, 1965), *salvia del pais* (Cuba, Pino et al. 2009; Milanés et al. 1999; Fernández and Torres 2006; Gupta 1995; Roig and Mesa 1928, 1965), *salvia olorosa* Puerto Rico, Nuñez 1992), *salvia real* (Middle America, Morton 1981) and *salvia santa* (Middle America, Morton 1981). The name *salvia* may refer to the European species *Salvia officinalis* L. The leaves are much alike, upper surface green and lower surface grayish and hairy. Both have a bitter taste. The common names, *cure for all* (Florida, USA, Woodmansee and Green 2006; Wilder and Roche 2009; Barbados, Honychurch 1986; Peter n.d.), *cureforal* (Panama, Gupta 1995), *guerit-tout (*French Guiana, DeFilipps et al. 2008), *Guétit-tout* (Haíti, Beauvoir et al. 2001 in Duke et al. 2009) and *geritout* (Trinidad and Tobago, Seaforth et al. 1983) are an allusion of the wide spectrum of medicinal application. Several common names refer to the medicinal uses of *P. carolinensis*. *Cough bush* (Bahamas, Austin 2004) indicate its use as an expectorant. In the former Aztec region of Mexico and Central America the common names *siguapote* (El Salvador, Honduras, and Guatemala, Gupta 1995), *siguapate* (Honduras, Ticktin and Dalle 2005; House et al. 1990), *ciguapate* (Guatemala, Kufer et al. 2005; Nicaragua, Gupta 1995) and *seguapeti* (El Salvador, Gupta 1995) signify in the Nahuath-lenguage, women medicine. *Chal-che* (Belize, Acevedo-Rodriguez 1996; Mexico, Steggerda 1943), *Chalche'* (Mexico, Ankli et al. 1999; Gupta 1995) means 'wash-quickly', referring to its use before, during and after childbirth (Austin 2004). *Sour bush* (Republic of Kiribati, Space and Imada 2004; Hawaii, Wood and LeGrande 2006; Starr et al. 2006; Englund et al. 2002; Bahamas, Eldridge 1975; U.S.Virgin Islands, Acevedo-Rodriguez 1996) refers to the bitter taste of its leaves as does *bitter tabacco* (Jamaica, Austin 2004). Smoking the leaves, like tabacco, may have given rise to the variety of common names with tabacco or tabac as its noun: *Bitter tabacco* (Jamaica, Austin 2004), *Indian tabacco* (Turks and Caicos Islands, Morton 1977), *tabac a Jacot* (Haíti, Beauvoir et al. 2001 in Duke et al. 2009), *tabac a jacquot* (Martinique, Slama et al. 2003), *tabac diable* (Martinique, Honychurch 1986), *tabac du diable* (French Guiana, DeFilipps et al. 2008), *tabac marron* (Middle America, Morton 1981), *tabac sauvage* (Haíti, Liogier 1990, 1996, 2000), *tabac zombie* Dominica, Honychurch 1986; Quinlan and Quinlan 2007) and *tabacco cimarron* (Panama, Austin 2004). The meaning of the common name *tabac a jacot* is explained by Austin (2004). In a game called 'Simon says' one imitates as a parrot (jacquot) imitates people. Thus *P. carolinensis* imitates the real tabacco.

Sweet scent (Puerto Rico, Nuñez 1992; U.S.Virgin Islands, Acevedo-Rodriguez 1996), *sweet scanted fleabane* (Middle America, Morton 1981), *coniza olorosa* (*odorous coniza*, Dominican Republic, Cordero 1986) and *conyse odorante (odorous conyse* Haíti, Liogier 1996, 2000), point out the odour of the plant. Formerly many species of *Pluchea* were placed in the genus *Conyse* (Greek, a flea) and hence the name *coniza* and *conyse*. In the Asteracea family several plants are called 'fleabanes' and are considered to repel fleas. Here we have several names who might refer to this action: *Bushy fleabane* (Middle America, Morton 1981), *hairy fleabane* (leaves are hairy dorsal, Middle America, Morton 1981)), *shrubby fleabane* (Middle America, Morton 1981) and *sweet scanted fleabane* (Middle America, Morton 1981; Austin 2004).

3 Crude Drug Used

All parts of *P. carolinensis* are used as a drug. However, the leaves are the part of the plant that is mostly used in the traditional applications. These can be fresh as well as dried. The most common application form is as a tea (infusion or decoction). Externally the leaves (fresh, boiled or warmed) can be placed on the affected area. They are collected generally in the wild. In some countries, Cuba, Venezuela and Panama, the plant is cultivated in home gardens (Morton 1981). In so-called Botánicas, herb stores in Latin America, the plant (generally dried leaves) is rather popular (Hodges and Bennett 2006).

4 Major Chemical Constituents and Bioactive Compounds

Sesquiterpenes of the type eudesmane and cuauthemone are widespread in the genus *Pluchea* (Ahmed et al. 1996, 1998; Jakupovic et al. 1985). The name cuauthemone has been derived from the Mexican medicinal plant named Cuauhtematl (*P. odorata*) (Nakanishi et al. 1974). This compound demonstrates growth inhibition against bean and corn seeds (pers. com. Dr. M.R. Grarciduenar in Nakanishi et al. 1974). This bicyclic eudesmene – type sesquiterpene was first synthesized by Goldsmith and Sakano (1976). The absolute configuration was elucidated by Torres-Valencia et al. (2003).

The essential oils of the leaves and flowers were separately investigated by Pino et al. (2005, 2009). There exists quite a difference between the main constituents of these two essential oils. The essential oil of the leaves contains principally: juniper camphor (37.6%), 3-thujopsanone (8.1%), ß-caryophyllene (7.6%), spathulenol (7.4%) and ß-chamigrene (5.9%), whereas the essential oil of the flowers is characterized by: selin-11-en-4α-ol (kongol) (43.4%), 2,5-dimethoxy-p-cymene (12.5%), caryophylle oxide (6.8%), nerylisovalerate (6.4%) and ß-chamigrene. This oil also contains different aldehydes and esters to give the floral odour. The main component

of the leaf oil, the sesquiterpene juniper camphor, is known as one of the principal ingredients of "Juniper Berry oil". This oil is widely used as a diuretic, stomachic, carminative in indigestion, kidney and bladder disorders, flatulence and rheumatism (British Herbal Medical Ass. 1983, Grieve n.d.). Recently isolated compounds, caffeic acid, chlorogenic acid, ferulic acid, quercetin and rosmarinic acid (Perera 2012) showed activity against *Leishmania amazonensis* (Montrieux et al. 2014). Several other biologically active compounds are present in *P. carolinensis* with the following pharmacologically activities: Taraxasteryl acetate, analgesic activity, (Palacios et al. 2008; Bahadir et al. 2010) and preventive effect on experimental hepatitis (Iijima et al. 1995); Isorhamnetin, anti-cancer activity (Lee et al. 2008; Ma et al. 2007; Teng et al. 2006); Kaempferol, bioactive dietary constituent (Calderón et al. 2011); Tannins, astringent (Haslam 1996).

In Table 1 the chemical constituents of *P. carolinensis* are mentioned.

Table 1 Chemical constituents of *Pluchea carolinensis*

Constituent	Plant part	References
Flavonols		
Isorhamnetin	Leaves	Perera et al. (2006a, b) Perera (2012), and Scholz et al. (1994)
Eupalitin	Leaves	Perera et al. (2006a)
Isorhamnetin-3-*O*-sulfate	Leaves	Perera et al. (2007)
3′,4′,5,6,7-pentahydroxy-3-methoxyflavone	Leaves	Perera et al. (2007)
Quercetin	Leaves	Perera et al. (2010), Perera (2012), and Scholz et al. (1994)
Quercitrin	Leaves	Perera (2012)
Quercetagetin	Leaves	Perera (2012)
Kaempferol	Leaves	Perera et al. (2010) and Perera (2012)
Myricetin	Leaves	Perera et al. (2010), Perera (2012)
Luteolin	Leaves	Perera (2012)
Herbacetin	Leaves	Perera (2012)
Sterols		
4,22-stigmastadien-3-one	Roots and stems	Lin (2009)
Terpenes		
3ß-Acetoxyurs-13 (18)-ene	Roots and stems	Lin (2009)
3ß-Angeloyl cuauhtemone	Aerial parts	Jakupovic et al. (1985)
3ß-Angeloyloxy-4-hydroxy-11-hydroperoxide-6,7-dehydroeudesman-8-one	Aerial parts	Jakupovic et al. (1985)
3-Thujopsanone	Essential oil[a] (leaf)	Pino et al. (2005)

(continued)

Table 1 (continued)

Constituent	Plant part	References
3α-(2′,3′-dihydroxy-2′-methylbutanoyl) 4,11-dihydroxy-6,7-dehydroeudesman-8-one	Aerial parts	Ahmed et al. (1998)
3α-(2′,3′-epoxy-2′-methylbutanoyl) 4α,11-dihydroxy-6,7-dehydroeudesman-8-one	Aerial parts	Ahmed et al. (1998)
3α-(2′,3′-epoxy-2′-methylbutanoyl) cuauhtemone	Aerial parts	Ahmed et al. (1998) and Jakupovic et al. (1985)
3α-(3′-chloro-2′-hydroxy-2′-methylbutanoyl) cuauhtemone	Aerial parts	Ahmed et al. (1998)
3α-(3′-chloro-2′-hydroxy-2′-methylbutanoyl)-4α,11-dihydroxy-6,7-dehydroeudesman-8-one	Aerial parts	Ahmed et al. (1998)
3α-Angeloyl cuauhtemone	Aerial parts	Ahmed et al. (1998)
3α-Angeloyloxy-4,11-dihydroxy-6,7-dehydroeudesman-8-one	Aerial parts	Jakupovic et al. (1985)
3α-Angeloyloxy-4-hydroxy-11-hydroperoxide-6,7-dehydroeudesman-8-one	Aerial parts	Jakupovic et al. (1985)
4α-Acetoxy-3α-(2′,3′-epoxy-2′-methylbutanoyl) cuauhtemone	Aerial parts	Ahmed et al. (1998) and Jakupovic et al. (1985)
4α-Acetoxy-3α-(2′,3′-epoxy-2′-methylbutanoyl)-11-hydroperoxide-6,7-dehydroeudesman-8-one	Aerial parts	Jakupovic et al. (1985)
4α-Acetoxy-3α-(2′,3′-epoxy-2′-methylbutanoyl)-11-hydroxy-6,7-dehydroeudesman-8-one	Aerial parts	Ahmed et al. (1998)
4α-Acetoxy-3α-(3′-chloro-2′-hydroxy-2′-methylbutanoyl)-11-hydroxy-6,7-dehydroeudesman-8-one	Aerial parts	Ahmed et al. (1998)
4α-Acetoxy-3α-angeloyloxy-11-hydroperoxide-6,7-dehydroeudesman-8-one	Aerial parts	Jakupovic et al. (1985)
5-Angeloyloxycarvotagetone	Aerial parts	Jakupovic et al. (1985)
5-*O*-Acetylcuauhtemonyl 6-*O*-2′,3′-epoxy-2′-methylbutyrate	Aerial parts	Ahmed et al. (1996)
α-Atlantone	Essential oil (leaf)	Pino et al. (2005)
Bicyclogermacrene	Essential oil (leaf)	Pino et al. (2005)
δ-Cadinene	Essential oil (flower)	Pino et al. (2009)
ß-Caryophellene	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
Caryophyllene oxide	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
ß-Chamigrene	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
Cuauhtemone	Aerial parts	Ahmed et al. (1998)
Cubebol	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
α-Gurjunene	Leaf	Sardans et al. (2010)

(continued)

Table 1 (continued)

Constituent	Plant part	References
γ-Gurjunene	Leaf	Sardans et al. (2010)
Juniper camphor (selin-7(11)-en-4α-ol)	Essential oil (leaf)	Pino et al. (2005)
Linalool	Essential oil (leaf)	Pino et al. (2005)
ß-Maaliene	Essential oil (flower)	Pino et al. (2009)
α-Pinene	Essential oil (leaf)	Pino et al. (2005)
α-Pinene	Leaf	Sardans et al. (2010)
Selin-11-en-4α-ol	Essential oil (flower)	Pino et al. (2009)
Selina-4,7-diene	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
α-Selinene	Leaf	Sardans et al. (2010)
Spathulenol	Essential oil (leaf)	Pino et al. (2005)
Taraxasteryl acetate	Aerial parts	Jakupovic et al. (1985)
2-(hex-5-en-1-3-diynyl)-5-(prop-1-ynyl) thiophene	Aerial parts	Jakupovic et al. (1985)
2-(but-3-en-1-ynyl)-5-(penta-1-3-diynyl) thiophene	Aerial parts	Jakupovic et al. (1985)
Thymohydroquinone dimethyl ether	Aerial parts	Jakupovic et al. (1985)
Valencene	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
Others		
3,4-O-dicaffeoylquinic acid	Aerial parts	Scholz et al. (1994)
	Leaves	Perera (2012)
4,5-O-dicaffeoylquinic acid	Aerial parts	Scholz et al. (1994)
	Leaves	Perera (2012)
3,5-O-dicaffeoylquinic acid	Aerial parts	Scholz et al. (1994)
	Leaves	Perera (2012)
3,4,5-O-tricaffeoylquinic acid	Aerial parts	Scholz et al. (1994)
	Leaves	Perera (2012)
1,3,4,5-O-tetracaffeoylquinic acid	Aerial parts	Scholz et al. (1994)
	Leaves	Perera (2012)
1,3-Di-O-[3,4-bis-(3,4-dihydroxyphenyl)-cyclobutane-1,2-dicarbonyl]-4,5-di-O-caffeoylquinic acid	Aerial parts	Scholz et al. (1994)
Caffeic acid	Roots and stems	Lin (2009)
	Leaves, flowers and stem	Perera (2012)
Caffeic acid methyl ester	Roots and stems	Lin (2009)

(continued)

Table 1 (continued)

Constituent	Plant part	References
2,6-Dimethoxy-1,4-benzoquinone	Roots and stems	Lin (2009)
2,5-Dimethoxy-p-cymene	Essential oil (flower, leaf)	Pino et al. (2005, 2009)
Neryl isobutyrate	Essential oil (flower)	Pino et al. (2009)
Tridecanal	Essential oil (flower)	Pino et al. (2009)
Neryl isovalerate	Essential oil (flower)	Pino et al. (2009)
Tannins	Leaves	Seaforth et al. (1983)
Chlorogenic acid	Leaves	Perera (2012)
Ferulic acid	Leaves	Perera (2012)
Rosmarinic acid	Leaves	Perera (2012)

[a]Only the main constituents of the essential oil are mentioned (>1.0%)

5 Morphological Description

"Erect shrub 1–2.5 m tall, much branched, branches densely tomentose. Leaf oblong-ovate to elliptic, 6–15 cm long, 2–6 cm wide, thinly tomentose and glandular on both surfaces, upper surface green, lower surface grayish, apex mucronulate-obtuse, margins entire or nearly so, base attenuate, petioles 1–2.5 cm long. Capitula 5–7 mm (when fresh) or ca. 10 mm (in dried specimens) in diameter, 6 mm long, peduncles 3–8 mm long, densely congested into terminal and axillary corymbs. Involucres ovate to campanulate, bracts greenish-purplish, 4-5-seriate; the outer very widely elliptic to very widely obovate, rounded at apex, 2–4 mm long, 1.5–2 mm wide, tomentose abaxially, ciliate at margins; the inner lanceolate to linear-lanceolate, acute at apex, 4–5 mm long, 0.5–1 mm wide, sparingly pubescent to glabrous. Receptacles flat, glabrous. Outer florets numerous, corolla filiform, pale greenish white, pinkish toward the summit, 3.5–4 mm long, tip 3-lobed; pappus white, slightly shorter than corolla; mature achenes not available for examination. Central florets ca. 20–25; corolla whitish, pinkish toward the summit, 4–5 mm long, sparingly glandular hairy at base; anthers obtuse at apex, shortly tailed at base; anthers and style exserted; achenes vestigial as a small, cartilaginous ring" (Peng et al. 1998).

6 Geographical Distribution

This tropical plant, *P. carolinensis*, is widely distributed in Central America, the Caribbean, the North of South America, and naturalized in Florida, Hawaii, Islands of the Pacific, and Taiwan (Villaseñor and Villareal 2006; van Belle n.d.; Dillon 2006; Peng et al. 1998; Anonymous 2010; Starr et al. 2006; Fosberg and Sachet

1987). Recently it has been described for the first time in the north of Peru (Dillon 2006).

7 Ecological Requirements

P. carolinensis is a shrub that is adapted to a wide variety of soils. It grows on wet and dry soils. However, it does not like shade. It is common in disturbed areas (US Forest Service n.d.). The plant is cultivated in gardens in Venezuela, Panama and Cuba and is sold on markets (Morton 1981). In Cuba, a phytosanitary study was performed to determine the illnesses, insects and present overgrowths in the nursery (Escandón and Méndez 2006). To-date, there is no further data on cultivation present in the literature.

8 Collection Practice

In Venezuela, Panama and Cuba the plant is cultivated in gardens and patios (Morton 1981). The leaves are generally collected in the wild.

9 Traditional Use (Part(s) Used) and Common Knowledge

In the literature, we have found a total of 186 recipes describing the traditional uses of *P. carolinensis* and these are distributed over 21 countries in North America, Central America, the Caribbean and South America. The plant is also found in the Islands of the Pacific and Taiwan, but no medicinal uses are reported. In North America, we have found information on its medicinal uses in Florida, the city of New York (USA) and Mexico. In Central America six countries, Guatemala, Belize, Honduras, Nicaragua, Costa Rica and Panama present data. Medicinal uses are recorded for Cuba, Dominican Republic, Trinidad and Tobago, Turks and Caicos, Bahamas, Puerto Rico, Dominica, Jamaica, Martinique and Haiti. *P. carolinensis* has its habitat in countries in the northern part of South America like Ecuador, Colombia and Venezuela. Recently it was described in the north of Peru (Dillon 2006). Remarkably, only from French Guiana have we found documents on the medicinal uses of this plant. Apparently, the medicinal value of this plant has not found its way in the traditional health systems in these countries. This is also the case in the islands of the Pacific and Taiwan. Here the plant is more considered as a rather aggressive, invasive weed (Global Invasive Species Database 2008). By far, most recipes refer to ailments, illnesses of the Respiratory tract (27%), followed by Pains (15%), Women Diseases (14%), the Digestive tract (12%), Fever (8%), Rheumatism (7%), Wounds (6%), Winds (3%), Liver (2%) and Sundries (6%).

In conditions of the Respiratory tract, the leaves are mostly used for *Throat* (Dominican Republic, Cordero 1986; Liogier 1990; Roersch, Unpublished results (Unp. Res.); Cuba, Godínez and Volpato 2008; Florida (USA), Hodges and Bennett 2006; Haíti, Liogier 2000; Belize, Arvigo and Balick 1993; Dominica, Quinlan and Quinlan 2007; Bahamas, Eldridge 1975; French Guiana, DeFilipps et al. 2008), *Cough* (Haíti, Liogier 2000; Belize, Arvigo and Balick 1993; Dominica, Quinlan and Quinlan 2007; Bahamas, Eldridge 1975), *Expectorant* (Haíti, Liogier 2000), *Hoarseness* (Cuba, Beyra et al. 2004; Godínez and Volpato 2008; Mexico, Morton 1981; Dominican Republic, Roersch, Unp.res.), *Flu* (Dominican Republic, Mañon et al. 1992, Roersch, Unp. Res.; Belize, Arvigo and Balick 1993; Martinique, Longuefosse and Nossin 1996; Guatemala, Gupta 1995; Honduras, Gupta 1995; French Guiana, DeFilipps et al. 2008), *Colds* (Belize, Arvigo and Balick 1993; Caribbean, Honychurch 1986; Guatemala, Kufer et al. 2005; Cuba, Beyra et al. 2004; Bahamas, Eldridge 1975; Morton 1981, French Guiana, DeFilipps et al. 2008; Trinidad and Tobago, Seaforth et al. 1983), *Chest colds with wheezing* (Turks and Caicos Islands, Morton 1977), *Pneumonia* (Cuba, Hernández and Volpato 2004), *Bronchopneumonia* (Dominican Republic, Roersch, Unp. Res.), *Bronchitic rattle* (Martinique, Longuefosse and Nossin 1996), *Catarrh* (Cuba, Volpato et al. 2009; Hernández and Volpato 2004; Beyra et al. 2004; Godínez and Volpato 2008; Florida (USA), Hodges and Bennett 2006; Mexico, Morton 1981), *Asthma* (Belize, Arvigo and Balick 1993), *Sinusitis* (Panama, Gupta 1995; Honduras, House et al. 1990). The second category is Pains. Generally the leaves are used as *Analgesic* (Puerto Rico, Nuñez 1992; Costa Rica, Gupta 1995), *pain* (Bahamas, Eldridge 1975; Nicaragua, Gupta 1995), *Ear pain* (Mexico, Heinrich et al. 1992), *Toothache* (Cuba, Beyra et al. 2004; Bahamas, Eldridge 1975; Morton 1981; Nicaragua, Gupta 1995; Florida (USA), Hodges and Bennett 2006; Dominican Republic, Roersch, Unp. Res.), *Thoracic pain* (Martinique, Longuefosse and Nossin 1996), *Chest pain* (Mexico, Steggerda 1943), *Headache* (Dominican Republic, Liogier 2000; Roersch, Unp. Res.; Guatemala, Kufer et al. 2005; Cuba, Godínez and Volpato 2008; Roig and Mesa 1928; Nicaragua, Gupta 1995; Panama, Gupta 1995; Trinidad and Tobago, Seaforth et al. 1983; Florida (USA), Hodges and Bennett 2006), *Migraine* (Cuba, Beyra et al. 2004; Puerto Rico, Alvarado-Guzmán et al. 2009), *Muscular pain* (Honduras, House et al. 1990), *Abdominal pain* (Honduras, House et al. 1990), *Azahar* (Guatemala, Kufer et al. 2005), *Whole body pain* (Nicaragua, Gupta 1995).

In the group of traditional ailments, i.e. Women Diseases, we have found 26 recipes of which 21 come from Mexico and Central America, where the local names *siguapate* (women medicine) and *Chalche* (wash-quickly) dominate. Mainly leaves are used for: *Pregnancy (to alleviate abdominal pain)* (Honduras, Ticktin and Dalle 2005), *Women in labor* (Mexico, Steggerda 1943), *After childbirth* (Belize, Arvigo and Balick 1993; Mexico, Steggerda 1943), *Expulsion of the placenta* (Mexico, Gupta 1995; Guatemala, Kufer et al. 2005; Bahamas, Eldridge 1975), *Desire of having a child* (Mexico, Ankli et al. 1999), *Fertility treatment or contraception* (Guatemala, Kufer et al. 2005), *Abortion* (Mexico, Ankli et al. 1999; Gupta 1995), *Miscarriage* (Honduras, Ticktin and Dalle 2005), *To induce menstruation* (Mexico, Gupta 1995), *Amenorrhea* (Mexico, Steggerda 1943), *Childbirth* (Haíti, Beauvoir

et al. 2001 in Duke 2009), *menstruation (pain)* (Mexico, Ankli et al. 1999; Guatemala, Kufer et al. 2005), *menstrual problems* (Mexico, Bork et al. 1997; Heinrich et al. 1992; Cuba, Godínez and Volpato 2008; Honduras, House et al. 1990), *Menstruation* (Dominican Republic, Roersch, Unp. Res.; Mexico, Steggerda 1943), *To regulate menstruation* (Honduras, House et al. 1990) *Matrix prolapse* (Martinique, Longuefosse and Nossin 1996), *Uterine fibroids* (USA (New York), Balick et al. 2000), *Galactagogue* (Mexico, Gupta 1995).

P. carolinensis is used to cure ailments of the Digestive tract. We have found the following traditional applications: *Stomach disorders* (Jamaica, Liogier 1990; Guatemala, Gupta 1995; Dominican Republic, Roersch, Unp. Res.), *Digestive* (Cuba, Godínez and Volpato 2008), *Stomachache* (Mexico, Bork et al. 1997; Heinrich 1989 in Scholz et al. 1994; Heinrich et al. 1992; Nicaragua, Gupta 1995; Honduras, House et al. 1990), *Dyspepsia* (Haíti, Beauvoir et al. 2001 in Duke 2009), *Intestinal pain* (Dominican Republic, Roersch, Unp. Res.; Mexico, Steggerda 1943), *Gastrointestinal parasites* (Heinrich 1989 in Scholz et al. 1994; Heinrich et al. 1992), *Diarrhoea* (Bork et al. 1997; Heinrich 1989 in Scholz et al. 1994; Heinrich et al. 1992; Nicaragua, Gupta 1995), *Gastrointestinal disorders* (Mexico, Frei et al. 1998; Guatemala, Gupta 1995), *Carminative* (Puerto Rico, Nuñez 1992), *Colic* (Nicaragua, Gupta 1995; Honduras, House et al. 1990), *Spasm* (Nicaragua, Gupta 1995), *Stomach ailments* (Florida (USA), Hodges and Bennett 2006), *Flatulence* (Florida (USA), Hodges and Bennett 2006), and *Constipation* (Honduras, House et al. 1990).

The next category, Fever, contains recipes from Spanish, French and English speaking nations. *P. carolinensis* is used for: *Fever* (Haíti, Liogier 2000; Beauvoir et al. 2001 in Duke 2009; Guatemala, Kufer et al. 2005; Cuba, Beyra et al. 2004; Volpato et al. 2009; Godínez and Volpato 2008; French Guiana, DeFilipps et al. 2008; Trinidad and Tobago, Seaforth et al. 1983; Turks and Caicos islands, Morton 1977; Mexico, Steggerda 1943; Honduras, House et al. 1990), *Fever and Chills* (Martinique, Longuefosse and Nossin 1996), *Diaphoretic* (Puerto Rico, Nuñez 1992), *To bring out the heat* (Nicaragua, Barrett 1994), *To cool the heat of the blood* (Nicaragua, Barrett 1994).

Regarding Rheumatism the following cases are mentioned: *Rheumatic pains* (Belize, Arvigo and Balick 1993; Venezuela, Morton 1981), *Rheumatism* (Guatemala, Kufer et al. 2005; Cuba, Hernández and Volpato 2004; Roig and Mesa 1928; Haíti, Beauvoir et al. 2001 in Duke 2009; Bahamas, Eldridge 1975; Martinique, Longuefosse and Nossin 1996; Nicaragua, Gupta 1995; Mexico, Steggerda 1943; Dominican Republic, Roersch, Unp. Res.; Honduras, House et al. 1990), *Arthritic joints* (Belize, Arvigo and Balick 1993).

For curing Wounds and swellings, only the leaves are used: *Wounds, purulent* (Dominican Republic, Cordero 1986), *Wounds* (Jamaica, Liogier 2000), *Pyoderma* (Cuba, Beyra et al. 2004), *Ulcers* (Jamaica, Liogier 2000), *Skin infections* (Mexico, Bork et al. 1997), *Tumors* (Belize, Arvigo and Balick 1993), *Bruises* (Belize, Arvigo and Balick 1993), *Swellings* (Turks and Caicos Islands, Morton 1977; Belize, Arvigo and Balick 1993), *Rash* (Florida (USA), Hodges and Bennett 2006), and *Antiseptic* (Florida (USA), Hodges and Bennett 2006).

The following category is Winds. This culturally bound syndrome is called in Spanish *Aires* or *Viento*, which is exclusively mentioned in Spanish speaking countries: Nicaragua (Gupta 1995), Panama (Gupta 1995), Cuba (Roig and Mesa 1928), Dominican Republic (Roersch, Unp. Res.) and Honduras (House et al. 1990).

The smallest category is Liver conditions, where the leaves and flowers of *P. carolinensis* are used for: *Liver* (Dominican Republic, Cordero 1986), *Hepatic complaints* (Mexico, Frei et al. 1998) and *Gallbladder* (Dominican Republic, Cordero 1986).

Finally, there is a wide range of other traditional diseases, for which *P. carolinensis* is used. To name a few: *Malaria* (Honduras, Liogier 1990), *Sore muscles* (Belize, Arvigo and Balick 1993), *Twitching muscles* (Mexico, Steggerda 1943), *Strains or dislocations* (Caribbean, Honychurch 1986), *Rubefacient* (Puerto Rico, Nuñez 1992), *Head cold* (Dominica, Quinlan and Quinlan 2007) and *Ear infection* (Mexico, Gupta 1995).

In the Turks and Caicos Islands people smoke the dried leaves like tobacco (Morton 1977). In Miami, Florida, *P. carolinensis* is a very popular plant which is sold in special stores called Botánicas (Hodges and Bennett 2006). Botanicas are health stores mostly frequented by Latinos (Latin-Americans) who look for remedies to alleviate not only their health problems but also their love problems. Also all kinds of religious objects are offered from amulets to pictures of saints (Gómez-Beloz and Chávez 2001). *P. carolinensis*, Salvia, is used for Mal de ojo (evil eye), Mala suerte (Bad luck), Limpiezas (ritualistic cleansings), mental problems, and as a spiritual panacea (Hodges and Bennett 2006). In Santo Domingo, the capital of the Dominican Republic, Salvia is also present in the Botánicas as a remedy for the throat, hoarseness and in baths to bring good luck (Roersch, unpublished results).

10 Modern Medicine Based on Its Traditional Medicine Uses

Dried ethanol extract (98%) of the leaves dissolved in H_2O showed inhibitory activity against *Enterobacter faecalis* (MIC 100 mg/ml), *Staphylococcus aureus* (MIC 100 mg/ml), *Mycobacterium* sp. (MIC 100 mg/ml), *Mycobacterium fortuitum* (MIC 100 mg/ml), *Mycobacterium* sp. (MIC 10 mg/ml), *Pseudomonas* sp. (MIC 100 mg/ml), *Escherichia coli* (MIC 100 mg/ml), *Klebsiella* sp. (MIC 1,0 mg/ml) and *Klebsiella* sp. (MIC 0,1 mg/ml) (Pérez et al. 2007). Antimicrobial activity against *Staphylococcus aureus* and *Bacillus subtilis* by the EtOAc (MIC = 1,0 mg/ml) and *n*-BuOH (MIC = 1,0 mg/ml) crude extracts of the leaves was studied by Perera et al. (2006a, b). The $CHCl_3$ extract showed activity against *Bacillus subtilis* (MIC = 1,0 mg/ml). The isolated compounds of the EtOAc extract, isorhamnetin and eupalitin, didn't demonstrate activity (Perera et al. 2006a, b). The aqueous infusion of the aerial parts and the isolated compounds 3,4,5-O-tricaffeoylquinic acid and 1,3,4,5- O- tetracaffeoylquinic acid demonstrated inhibition against *Bacillus*

subtilis (MIC = 360 μg/ml, 110 μg/ml, 80 μg/ml respectively), *Escherichia coli* (MIC = 3300 μg/ml, 330 μg/ml, 330 μg/ml respectively) and *Micrococcus luteus* (MIC = 3300 μg/ml, 660 μg/ml, 330 μg/ml, respectively) (Scholz et al. 1994).

Different extract of the aerial parts did not show antifungal activity in vitro against *Cladosporium cucumerinum* and *Penicillum oxalicum* (Scholz et al. 1994). The $CHCl_3$ extract of the aerial parts gave in vitro nematocidal activity against *Caenorhabditis elegans* (ED_{50} = 250–500 μg/ml). In vivo activity against *Trichostrongylus colubriformis* in jirds (*Meriones unguiculatus*) given orally and given subcutaneously at a single dose of 200 mg/ml reduced the worm burden by 30% and 40% respectively. 1,3,4,5-O-tetracaffeoylquinic acid had also in vitro nematocidal activity against *Caenorhabditis elegans* (ED_{50} = 125–250 μg/ml). However, in vivo (200 mg/ml) it didn't show activity against *Trichostrongylus colubriformis* in jirds (*Meriones unguiculatus*) given orally and given subcutaneously it had a reduced effect (worm burden reduced by 15%) (Scholz et al. 1994). The ethanolic and hydro-ethanolic leave extracts showed antifungal activity against *Candida* and *Trichophyton* spp. ($200 \leq MIC \leq 400$ μg/ml) (Biabiany et al. 2013).

$CHCl_3$ and EtOAc extract of the aerial parts and 1,3,4,5-O-tetracaffeoylquinic acid showed in vitro low antiamoebic activity against *Entamoeba histolytica* (IC_{50} = 250–500 μg/ml, 250–500 μg/ml and 125–250 μg/ml respectively) (Scholz et al. 1994).

Antioxidant activity was investigated using the L-epinephrine oxidation by hydroxyl radical generated in the Fenton reaction. This was inhibited by the crude phenol (conc. 40, 60, 80 and 100 μg/ml) and 50% ethanol extract (conc. 100, 200, 300 and 400 μg/ml) from the leaves of *P. carolinensis* in a dose-dependent manner (Fernández and Torres 2006). In vitro antioxidant activity, using the DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2′-azino-bis(3-ethylbenzthiazoline-6-sulfonic acid) methods, were highest for the EtOAc and *n*-BuOH extracts of the leaves (Perera et al. 2010).

Antileishmanial activity was investigated with a Cuban species of *P. carolinensis*. However, the results are somewhat confusing. In their first publication, Garcia et al. (2010) inform that the ethanolic extract (80%) of the leaves hardly inhibit the growth of promastigotes of *L. amazonensis* at concentrations of 50 μg/ml (inhibition 13.5%) and 100 μg/ml (inhibition 12.7%), whereas in their second publication, Garcia et al. (2011) mention that *P. carolinensis* inhibits 50% of promastigote growth at a concentration of 30 μg/ml, without referring to their first article. The pure compounds from *P. carolinensis*, caffeic acid, chlorogenic acid, ferulic acid, quercetin and rosmarinic acid, showed inhibitory activity against promastigotes (IC_{50} = 0.2–0.9 μg/ml) and intracellular amastigotes (IC_{50} = 1.3–2.9 μg/ml). In BALB/c infected mice, caffeic acid, ferulic acid, and rosmarinic acid controlled lesion size development and parasite burden in footpads (Montrieux et al. 2014).

Tincture (30%) of the plant (part not specified) has a significant in vivo anti-inflammatory activity in acute and chronic processes by using carrageenan-induced rat paw edema (doses 80 mg/ml of tincture, orally) and the cotton-induced granu-

loma model (doses 80 mg/ml of tincture, orally) (Rosales et al. 1999). The ethanolic extract (96%) of the aerial parts did not show activation (conc. 100 μg/ml) of the transcription factor NF-κB in HeLa cell culture (Bork et al. 1997).

Weak antispasmogenic effect (conc. 0.1 ml) was observed using the Guinea-pig ileum with the aqueous extract of the leaves and succulent stems. From this extract, the high molecular weight material was precipitated with ethanol and the resulting extract also showed weak antispasmogenic effect (conc. 0.5 g/ml) using the Guinea-pig ileum. In addition vasodilator activity in the rat hind limb (conc. 0.01 g/ml) was demonstrated (Feng et al. 1962).

Aqueous infusion of the aerial parts had a weak antisecretory effect (conc. 250 μg/ml) on the isolated rabbit colon (inhibition of prostaglandin E_2 stimulated Cl^- secretion) and the EtOAc extract of the aerial parts did not have any antisecretory effect (conc. 750 μg/ml) on the isolated rabbit colon (inhibition of prostaglandin E_2 stimulated Cl^- secretion) (Scholz et al. 1994).

11 Toxicology

The toxicity of the ethanolic extract (70%) of the leaves of *P. carolinensis* was evaluated using the Toxicity Class Method. The only applied doses of 2000 mg/kg did not produce any deaths among the test animals (rats) during the observation period of 14 days. Afterwards, an anatomo-pathological assessment was performed and no macroscopic alterations were observed in the external surface and in the cavities, organs and tissues (Arteaga et al. 2008). Feng et al. (1962) found that mice were killed applying 0.5 ml (intraperitoneally) of a water extract (conc. 5 g/ml) or 1.0 ml water/ethanol extract (conc.1 g/ml) of the leaves.

12 Conclusions

The large number of common names given to *P. carolinensis* indicates the popularity of this medicinal plant. Even after migration, Latin-Americans (Hispano-Americans) visit their herb stores (Boticas) to purchase this plant. Also, the conformity in traditional uses between Spanish, French and English speaking cultures is remarkable. However, until now very few biological, pharmacological experiment are carried out to corroborate the traditional uses. Clinical experiments are completely absent. The principal traditional uses, illnesses of the Respiratory tract, are hardly confirmed with laboratory data. The second group of traditional ailments, Pains, has some confirmation. The principle use in Central America and Mexico, in Women diseases, have not received any attention so far. Generally, the biological/pharmacological part is poor. The experiments related to the anti-Leishmania activity of the extracts and pure compounds are promising.

To resume a very interesting medicinal plant with very little attention from the scientific world.

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