Baccharis trimera (Less.) DC.

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Baccharis trimera (Less.) DC.
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Abstract The producer of medicinal plants can be considered different from others because they need to know the whole steps from cultivation to harvest for each plant, including botanical identification, harvest time, temperature of drying, how to store and, in some cases, the medicinal purposes. Producers of *Baccharis trimera* (Less.) DC., for example, must know its botanical characteristics in order to avoid problems of confusion with *Baccharis coridifolia* DC. (broom), which belongs to the same genus, but it is toxic. *B. trimera*, also known as "Carqueja", is native from Brazil and is among the most important native medicinal plants of Brazil. Furthermore, *B. trimera*, has an ethnopharmacological importance for traditional people. It has many chemical compounds, and among the main are essential oils, sesquiterpene alcohols, resins, vitamins, tannins, flavonoids, lactones and saponin. Fresh or dehydrated *B. trimera* is marketed to produce phytotherapics, teas and is also used in the brewing industry, as well as replacement of hops for flavoring drinks, liqueurs and "cachaça". However, there is only one cultivar of *B. trimera*, called "CPQBA-1". Pioneering agronomic works done with it have shown promising results to cultivate it in the field, but still further studies are needed to ensure the quality and quantity of material.

Keywords Carqueja · Var. CPQBA-1 · Agronomic features · Medicinal purposes · Chemical substances

1 General Aspects

Agronomic research with native medicinal plants in Brazil is rare, as compared to exotic plants (Alonso 1998). This is one of the reasons that hinder the organization of national production of native medicinal plants (Souza et al. 2012). Moreover, the lack of information on the agronomic steps of these plants (Cortés et al. 2007) contributes to obtaining vegetable with the poor quality product (Veiga Jr. 2008), and increases the indiscriminate collection in natural environments (Carvalho 2003). According to Menezes Jr. (2006), about 90% of native medicinal species consumed in Brazil comes from collections without management. Additionally, Reis and Mariot (1998) alert that in Vale do Ribeira do Iguape region (West of São Paulo, Brazil) *Baccharis trimera* (Less.) DC. may be at risk of extinction due to exploration without appropriate management. The *B. trimera* cultivar "CPQBA-1" was the first recorded for a medicinal plant species, in Brazil's Ministry of Agriculture, Livestock and Supply (MAPA), in 2007, under the reference number 21190 (Montanari Jr. et al. 2008). This cultivar has very similar morphological characteristics to the wild type, except by the largest size that can reach up to 1.5 m tall. Another highlight of farming this cultivar is that it is adapted to agricultural environments, has uniform flowering, resistance to environmental factors and high germination rate (Montanari Jr. 2002).

2 Taxonomic Characteristics

B. trimera is native to South and Southeast of Brazil. It is popularly known as carqueja, broom-bitter, bacorida, carque, edge-of-condamine, broom, witches' button sedge-of-frill (Alzugaray and Alzugaray 1988), sweet (Pavan-Fruehauf 2000), and bacanta-Cacalia-bitter (Lorenzi and Matos 2008). These species have two scientific synonyms: *Baccharis genistelloides* var. *trimera* (Less.) Baker and *Molina trimera* Less. (Lorenzi and Matos 2008; Brazilian Pharmacopoeia 2010).

B. trimera belongs to the Asteraceae family. The more than 500 species belonging to the genus *Baccharis* are distributed from the United States of America (Fielding 2001) to the southern tip of Argentina and Chile (Hellwig 1990; Giuliano 2001), much of which is present in South America (Tropicos 2013). In Brazil, the genus *Baccharis* is represented by 120 species, distributed in larger quantities in the southern region (Barroso et al.1991). Some of these species are known for their toxicity, such as *B. coridifolia* (Abreu Matos et al. 2011).

3 Major Chemical Constituents and Bioactive Compounds

The essential oil of *B. trimera* contains monoterpenes (α- and *β*-pinene, nopineno) and sesquiterpene alcohols (carquejol, terpene esters). Soicke and Leng-Peschlow (1987) have investigated the fresh ethanol extract of *B. trimera* and found a mixture of five flavonoids: quercetin, luteolin, nepetina, apigenin and hispidulin. They also found in the same extract: flavones and flavonones; flavonoids, lactones and saponin (Santos et al. 1988; Simões et al. 1998; Pocá 2005), and resin, vitamins, polyphenols, tannins, *α*- and *β*-cadinene, calameno, eledol and eudesmol (Oliveira and Akisue 1997).

The carquejol and carquejila acetate are common in *B. trimera* (Siqueira et al. 1985; Souza et al. 1991), but Palácio et al. (2007) did not detect both chemical compounds in their analysis of essential oil. Lago et al. (2008) also did not notice the carquejila acetate in essential oil of *B. trimera* var. CPQBA-1. Carvalho (2003), evaluating the chemical composition of essential oil from *B. trimera* found great variability in the chemical compounds and in some samples the presence of carquejol and carquejila acetate was not observed, and in another sample was found only carquejila acetate. Morais and Castanha (2011) suggest that the lack of these substances in the analysis may indicate that the species are not *B. trimera*. However, Palácio et al. (2007) confirm that there is the possibility of decomposition of these substances during the extraction process or they may be modified due to the conditions of plant growth. Garcia et al. (2017) did not find both chemical compounds in the analysis of essential oils of *B. trimera* var. CPQBA-1, corroboration with Palácio et al. (2007).

Morais and Castanha (2011) evaluated the chemical composition of two populations of *Baccharis* sp. located in Rio de Janeiro state (Brazil). The authors identified 19 chemical compounds and the main were: *trans*-caryophyllene (22%), spathulenol (13.8%), ledol (13.7%), caryophyllene oxide (8.3%), germacrene-*D* (7%) and bicyclogermacrene (8.5%).

Working with *B. trimera* var. CPQBA-1, Lago et al. (2008) obtained different proportions of chemical compounds in essential oil from male and female plants, but only β-elemene, (*E*)-caryophyllene, aromadendrene, bicyclogermacrene, δ-cadinene, germacrene-*B*, caryophyllene oxide, epi-a-muurolol and α-cadinol were detected in both genders. The main components found in female plants were: (*E*)-caryophyllene, cadinene and α (more than 10%). The main substances found in male plants were: α-humulene and germacrene *D*.

It is known that the terpenoids have protective functions in plants, such as protection against herbivores and microbial activity (Owen and Peñuelas 2005). In work conducted with the cultivation of *B. trimera*, Garcia et al. (2017) identified in whole treatments with escalating doses of organic compost and three harvests the higher accumulation of five chemical compounds: trans-caryophyllene, caryophyllene oxide, spathulenol, bicyclogermacrene and germacrene-*D* (Table 1).

4 Morphological Description

According to the macroscopic analysis described in the Brazilian Pharmacopoeia (2010), *B. trimera* has three wings, cylindrical branches, up to 1 m in length, with rare leafless or sessile and reduced the leaf nodes. Green wings, glabrous, membranous, with 0.5–1.5 cm wide, wards of the flowering branches are narrower than the other. It is dioica plant and when it has flowering branches, these should only be pistillate or only staminate. Inflorescences, when present, the chapter type, yellowish-white, numerous, sessile, arranged along the upper branches. Staminate bracts involucres chapters 0.4–0.5 cm long and gradually the smaller oval and external glabrous, flower with corolla tube form, pentamerous up to 0.4 cm in length. Pistillate chapters up to 0.6 cm long, flowers with filiform corolla, with up to 0.4 cm long; type of fruit achenes, up to 0.2 cm in length with 10 longitudinal grooves.

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

B. trimera is one of the native medicinal plants from Brazil that has a high level of importance in the Brazilian scenario (Furlan 2005). Naiverth and Faria (2007) have emphasized that it is the fourth most widely used medicinal plant in the Pato Branco city (Paraná state, Brazil). Silva Jr. (1997) points out that the region is one of ten medicinal species sold in Brazil. *B. trimera* is sold in the domestic market in dried

Table 1 Biological activities of main chemical compounds of *B. trimera* var. CPQBA-1 and other species that contain the same substances

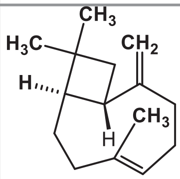
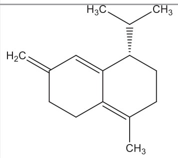
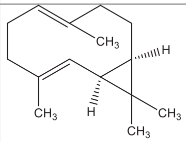
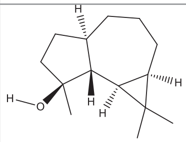
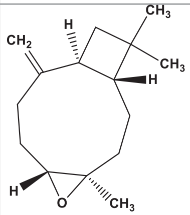
Chemical compound isolated	Molecule	Vegetal species	Biological activity	Scientific literature
Trans-caryophyllene		Lippia chevalieri	Antibacterial activity (Staphylococcus aureus and Enterococcus hirae); antifungal (*Saccharomyces cerevisiae*)	Mevy et al. (2007)
Germacrene-D		Senecio desiderabilis	Antimicrobial activity	Deuschle (2003)
		S. heterotrichius	Antifungal and antimicrobial activity	Francescato et al. (2007)
		S. bonariensis	Do not have antifungal and antimicrobial activity	Silva et al. (2010)
Bicyclogermacrene		Araucaria columnaris, Agathis moorei, A. ovata, Callitris sulcata, Neocallitropsis pancheri	Natural acaricide	Lebouvier et al. (2013)
Spathulenol		Melaleuca spp.	Antibacterial activity	Amri et al. (2012)
Caryophyllene oxide		Baccharis trimera	Natural formicide	Marques et al. (2009)

Table 2 Main chemical compounds in the essential oil of *B. trimera*

Main substances	July (%)	August (%)	September (%)	October (%)
Carquejila acetate	68	42,3	60	58,5
β-pinene	5,6	12,6	11,3	12,3
Ledol	5,9	7,2	7,1	7,5
Limonene	3,4	4,2	4,7	4,0

Adapted from Simões-Pires et al. (2005)

form, in capsules, tinctures or tablets (Silva et al. 2006). Pocá (2005) listed some products containing *B. trimera* in its formulation found in the local market of Curitiba city (Paraná state, Brazil), e.g.: capsules, teas in sachets and packets.

B. trimera is known to grow better in full sun (Bona 2002). Is commonly found on roadsides, areas of high slope and wetlands (Correa Jr. et al. 2006). Furthermore, it is considered a weed in fields and pastures (Bona 2002). As for pests, it is usually attacked by aphids, scale insects and chewing (Andrião 2010). With regard to diseases, powdery mildew and some leaf spots (Bona 2002) occur.

The best planting time is from September to October, and culture must be renewed every 3 or 4 years (Correa Jr. et al. 2006; Trani et al. 2007).

The propagation is made of sexual (Castro 1998) and non-sexual form (Biase and Bona 2000; Sousa et al. 2006; Reis et al. 2007; Andrião 2010). Because it is a dioica plant, the agametic propagation of wild species and an except for sexual propagation to *B. trimera* var. CPQBA-1 is recommended (Garcia et al. (2017)).

Seasonality can influence on accumulation of different chemical compounds (Gobbo-Neto and Lopes 2007), as was demonstrated by Simões-Pires et al. (2005), who identified the following proportions of the main chemical compounds in the essential oil of *B. trimera* harvested at four different times in the Guaíba municipality (Rio Grande do Sul state, Brazil) (Table 2).

Regarding the cutting height, Mol et al. (2002) and Bona (2002) suggest leaving 10 cm of aerial part for regrowth, and Palacio et al. (2007) recommend leaving 30 cm.

Regarding the post-harvest of medicinal plants, Correa Jr. et al. (2004) and Reis et al. (2007) suggest that the drying must be done quickly in order to stop the enzyme and microorganisms activity, and consequently, reduce the degradation of their chemical compounds. Andrião (2010) and Garcia et al. (2017) recommend 38 °C as drying temperature of *B. trimera* on the artificial dryer with forced air circulation.

When there is no production of medicinal plants in crops planned, the outcome about the genetic, chemical and sanitary qualities of vegetal material collected is uncertain (Correa Jr. et al. 2004). It should be added that the *B. trimera* has greater genetic variability to be dioica, which also hampers the security of chemical homogeneity of wild plants, those who have not gone for a breeding program.

The aggravating scenario indiscriminate collection of native medicinal plants from Brazil, plus the demand of these plants by industries and population, stimulated the search for development of cultivars. In 2007, *B. trimera* var. CPQBA-1 was registered at the Ministry of Agriculture, Livestock and Supply (MAPA, Brazil) by the Multidisciplinary Center for Chemical, Biological and Agricultural Research

(CPQBA, Brazil) as the first cultivar of the native medicinal plant from Brazil (Montanari Jr. et al. 2008). This cultivar was selected as to dumping, germination dynamic and vigorous growth by the mass process with gametic control for five generations, including parental generation. A voucher specimen was deposited in the CPQBA Herbarium (Brazil) under number 1286.

Davies (1999) has obtained 180 kg ha^{-1} of dry *B. trimera* at 150 DAT. Garcia et al. (2017) obtained 1600 kg ha^{-1} of dry matter at 242 DAT (first regrowth). On the other hand, the results obtained in these studies differ drastically from those obtained by Palacio et al. (2007), who collected data from higher dry matter of *B. trimera* (4600 kg ha^{-1}) at 180 DAT. In this work, the authors used doses and different nitrogen sources (urea and sheep dung containing 4, 8 and 16 g N.$plant^{-1}$) suggesting that this fact may have occurred probably due to initial growth capacity of *B. trimera* as well as influenced by environmental conditions (Pinhais city, Paraná state, Brazil).

Despite there is little information about nutritional aspects of native medicinal plants from Brazil and its development in the field (Cortés et al. 2007), it is known that the availability of nutrients in the soil solution during the life cycle of plants is one of the conditions when wants achieve greater biomass production (Chaves 2002). Thus, it becomes essential to encourage related studies of native medicinal plant, because these lead to understanding and improving the management, thus justifying the production of raw materials with more desirable physicochemical and phytochemical properties industrially marketable.

6 Modern Medicine Based on Its Traditional Medicine Uses

When searching for plants with pharmacological properties in the environment, usually related to the ethnopharmacology studies contribute significantly without having to search for them randomly (Garcia 2009). Some of the main popular uses of *B. trimera* recorded in the scientific literature are to: digestive, diuretic, hepatoprotective, hypoglycemic and combating anemia (Castro and Ferreira 2000), antiemetic and antinauseant (Barbano 2006) and the whole plant as a mild sedative (Garcia et al. 2010).

Many laboratory studies with *B. trimera* has proved its pharmacological potential as: anti-hepatotoxic activity (Soicke and Leng-Peschlow 1987), anti-inflammatory and analgesic (Gené et al. 1996), sedative (Torres et al. 2000), anti-proteolytic and anti-hemorrhagic (Januário et al. 2004), antioxidant (Simões-Pires et al. 2005), antidiabetic (Oliveira et al. 2005) and antisecretory (Biondo et al. 2011). Preliminary studies indicate that some active principles of *B. trimera* act in lowering blood pressure (Saúde 2013). Nevertheless, Grance et al. (2008) observed toxicity activity of the aqueous extract of *B. trimera* cells in the liver and kidneys of pregnant rats; however, a reverse of this toxicity is shown when the extract is used discontinuously.

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