# *Clinopodium gilliesii* (Benth.) Kuntze

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*Clinopodium gilliesii* (Benth.) Kuntze
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**Abstract** *Clinopodium gilliesii* (Benth.) Kuntze is an aromatic species from the Andean region, from southern Peru to northern-central Argentina. It is mainly known as *muña-muña* and its leaves and tender stems are used as a flavoring and medicinal: stimulant, against mountain sickness, aphrodisiac, digestive, antispasmodic, among others traditional uses. Its bioactive constituents are essential oils, to which the plant owes its aroma and many of its therapeutic properties. The presence of flavonoids and phenolic compounds has also been detected. The essential oil composition of aerial organs is variable according to geographical location and ecological conditions, soil-type, weather-conditions and altitude of the population. Regarding its popular uses, the majority of uses has not been validate by pre-clinical tests, therefore they require experimental founding. Some of its biological activities, e.g.: aphrodisiac (in particular, erectile dysfunction), against some gastrointestinal disorders, antibacterial, antifungal, antiplasmodial, trypanocidal, insect repellent, antioxidant, and cytotoxic activities have already been analyzed. Some data about the similar species: *C. bolivianum* (Benth.) Kuntze and *C. odorun* (Griseb.) Harley is additionally commented.

**Keywords** *Clinopodium gilliesii* · Lamiaceae · Muña-muña · Andean region · Food and medicinal uses

## 1 Taxonomic Characteristics

*Clinopodium gilliesii* (Benth.) Kuntze is an Andean aromatic plant utilized for centuries for medicinal purposes: stimulant, aphrodisiac, digestive, among others. It is also used in different local gastronomies as a food condiment and to flavor milk, infusions, and aperitifs, due to its aroma similar to the mint. The most widespread vernacular name is muña-muña (from Quechua *munay*, 'to love', by referring to its application as an aphrodisiac). It is also called hierba del amor, koa, muiña, mullamulla, muña, oreganillo, yerba del amor, yerba del pajarito (Barboza et al. 2009; Hurrell et al. 2008, 2011).

The genus *Clinopodium* belongs to the Family Lamiaceae Martinov, Tribe Mentheae Dumort., and comprises about 100 species, mostly in temperate and tropical New World, and temperate Eurasia, but a few in Africa, tropical Asia and Indomalaysia (Harley et al. 2004). This generic circumscription responds to morphological and molecular studies that defined the boundaries within the complex *Satureja* L./*Calamintha* Mill./*Acinos* Mill./*Micromeria* Benth./*Xenopoma* Willd. (Cantino and Wagstaff 1998; Harley and Granda Paucar 2000; Wood 2011). In this frame, *Clinopodium* includes most of the New World native species of *Satureja* sensu lato (Harley et al. 2004).

Other Andean species of this genus are also utilized for its aromatic and medicinal properties, e.g. *Clinopodium nubigenum* (Kunth) Kuntze [= *Thymus nubigenus* Kunth, *Satureja nubigena* (Kunth) Briq.], sunfillo, from Colombia and Ecuador, *Clinopodium pulchellum* (Kunth) Govaerts [*Gardoquia pulchella* Kunth, *Satureja*

*pulchella* (Kunth) Briq.] and *Clinopodium bolivianum* (Benth.) Kuntze [*Micromeria boliviana* Benth., *Satureja boliviana* (Benth.) Briq.], inca-muña, koa, oregano of the Incas, from Peru, Bolivia and Northwest Argentina, *Clinopodium odorum* (Griseb.) Harley (*Xenopoma odorum* Griseb., and *Satureja odora* (Griseb.) Epling), muña, from Bolivia and Northwest-central Argentina (Pontiroli 1993; Orfila and Farina 1997; Ulloa 2006; Elechosa 2009; Álvarez Sarmiento 2012).

**Synonyms** *Bystropogon minutus* Briq.; *Micromeria gilliesii* Benth.*; Micromeria eugenioides* Hieron; *Oreosphacus parvifolia* Phil.; *Satureja gilliesii* (Benth.) Briq.*; S. oligantha* Briq.*; S. parvifolia* (Phil.) Epling; *Satureja eugenioides* (Griseb.) Loesener ex R.E.Fries; *Xenopoma eugenioides* Griseb.

## 2 Crude Drug Used

The drug consists of its leaves and tender stems, sometimes with flowers. Both fresh and dried leaves and stems are used for culinary and therapeutic purposes.

The dry leaves and stems are consumed mostly in infusions or decoctions (20 g per liter of water), two or three cups in daily intakes, also in mother tincture (25 g in 100 cc of 70° alcohol), 25–30 drops in water, three times a day (Burgstaller 1968; Alonso and Desmarchelier 2005; Hurrell et al. 2011).

In the pluricultural urban scenarios, its leaves and tender stems and tincture are commercialized in herb-shops and health food stores, and disseminated by the media, especially the Internet. The dried leaves and stems are sold in bulk or packaged (Hurrell et al. 2011).

## 3 Major Chemical Constituents and Bioactive Compounds

The essential oil composition from the aerial parts of *C. gilliesii* varies according to geographical areas and its ecological conditions, as soil, weather, and altitude (Viturro et al. 2000). This variable composition is responsible for different scents, defined by olfactory characteristics as mint-like, lemony, fresh, ketonic, phenolic, persistent (Elechosa 2009).

The main essential oils indicated are: carvacrol, carvacryl acetate, carvona, *o*- and *p*-cimene, 1-8-cineol, *cis*-dihydrocarvone, dihydrolippiona, geraniol, *E*-isocitral, isopulegol, limonene, linalool, lippiona, menthol, menthone, methyl nerolate, myrcene, neoisomentol, α- and β-pinene, piperitenone, piperitenone oxide, piperitone, piperitone oxide, pulegone, sabinene, α -thujene. Its flavonoids (e.g. luteolin) and phenolic compounds content have also been studied (Zygadlo et al. 1993; Muschietti et al. 1996; Hernández et al. 2000; Viturro et al. 2000, 2007; Alonso and Desmarchelier 2005; van Baren et al. 2006; Barboza et al. 2009; Dadé et al. 2009; López-Lázaro 2009; Niemeyer 2010; Cabana et al. 2013; Tepe 2015).

## 4 Morphological Description

*C. gilliesii* is an aromatic shrub up to 2 m in height, with glabrescent or shortly pubescent branches. Leaves opposite, sub-sessile, simple, oblong, 0.4–2 cm long × 0.1–0.5 cm wide, apex obtuse, margin entire, both faces dotted-glandular and finely pubescent; pubescence is more pronounced in the adaxial face midvein. Axillary verticillasters with three to six flowers or reduced to a single flower, subtended by linear bracts, 1 mm long; pedicels short. Calyx campanulate, pubescent, tube 1–2 mm long, teeth 5, deltoid, acute, subequal, 0.6–1 mm long, somewhat curved. Corolla 2-lipped, white, 2–2.5 mm long, glabrescent, tube exserted, 1.2–1.5 (−2) mm long, upper lip 2-lobed, emarginate, lower lip with three equal lobes. Stamens 4, included, didynamous, the upper ones shorter, thecae divergent. Ovary 2-carpelar, 4-lobed; style enlarged to the base. Fruit formed by four mericarps (nutlets) included in the persistent calyx. Mericarps obovoid, 1.5–1.7 mm long, brown, finely reticulate, apex obtuse or subacute.

Among the species of *Clinopodium* of Bolivia and northeast-central Argentina, *C. odorum* basically differs from *C. gilliesii* by its ovate leaves, 6–20 mm lat., with margins pubescent; meanwhile *C. bolivianum* differs from the two previous by its shorter corolla tube (6–8 mm long.), and its stamens shortly exserted (Pontiroli 1993; Orfila and Farina 1997; Harley et al. 2004; Elechosa 2009).

## 5 Geographical Distribution

This species is native to the Andean region of southern Peru, Bolivia, Chile and Argentina (Jujuy, Salta, Tucumán, Catamarca, La Rioja, Córdoba, San Juan, San Luis and Mendoza), from 1000 to 4500 m altitude (Pontiroli 1993; Del Vitto et al. 1997; Orfila and Farina 1997; Flores and Ruiz 2006; Hurrell et al. 2011; Wood 2011).

## 6 Ecological Requirements

*C. gilliesii* is particularly characteristic of the arid highland Andes. It is more frequent in the upper floor of montane forests, ‘ceja de monte’ scrub (boundaries of forests), puna vegetation and drier inter-Andean valleys (Orfila and Farina 1997; Wood 2011).

It is a versatile species with a wide range of tolerance to variation in environmental conditions, especially drought and frost, although their growth is optimal in the rainy season when water availability is not a limiting factor. Also tolerates acid soils with moderate moisture (Flores and Ruiz 2006).

## 7 Collection Practice

As mainly wild plants are collected, the danger of becoming threatened by overexploitation is imminent, in Argentina (Viturro et al. 2007). Branches should be collected when plants are in full bloom (late spring to early autumn). In young plants or second collections make good net cuts at least 10 cm of soil, avoiding uprooting the plants. In older plants, cut branches of smaller diameter 1 cm, leaving 20–30 cm at the bottom. In sustainable harvest, the branches are shaken before bagging, to cause the fall of mature seeds (Elechosa 2009).

The leaves and tender stems that are employed fresh to flavor foods or beverages are harvested just before be used (Hilgert 1999).

In its spontaneous distribution area, it is also cultivated in home gardens (Pochettino et al. 2012), usually for own consumption medicinal purposes. Its cultivation is relatively easy, and it is reproduced by seeds, but is more convenient and simple the multiplication by cuttings (Alonso and Desmarchelier 2005). In vitro propagation was assayed (Díaz et al. 2011).

## 8 Traditional Use (Part(s) Used) and Common Knowledge

*C. gilliesii* has a long history of utilization in folk medicine within its spontaneous distribution area. Currently, the dried leaves and tender stems are commercialized in urban herb shops and health food stores to prepare infusions and decoctions; its mother tincture is also marketed (Hurrell et al. 2011).

Its main traditional therapeutic uses include: to treat digestive disorders, and the mountain sickness (‘apunamiento’, ‘mal de puna’ or ‘soroche’: dizziness, headache, nausea, vomiting, lack of appetite, physical exhaustion), aphrodisiac and emmenagogue (Hieronymus 1882; Burgstaller 1968; Orfila 1972; Ratera and Ratera 1980).

Regarding digestive disorders it is consumed as a digestive stimulant, bitter-tonic, stomachic (eupeptic), antacid, antiulcer, to treat stomach aches, and to cure the *empacho* (severe indigestion because many causes, mainly the excessive food intake) mainly in children, antispasmodic, cholagogue, choleretic, carminative, purgative (Bustos et al. 1996; Del Vitto et al. 1997; Hilgert 2001; Villagrán and Castro 2003; Alonso and Desmarchelier 2005; Gupta 2006; Rondina et al. 2008; Campos-Navarro and Scarpa 2013; Ceballos and Perea 2014).

In relation to reproductive medicine, its aphrodisiac properties refer to its use as stimulating libido and to treat male sexual dysfunction (impotence). *C. gilliesii* is utilized also as an emmenagogue, in case of menopausal ailments, to increase fertility, against female infertility, pregnancy and postpartum pains, and facilitating childbirth (Hieronymus 1882; Hilgert and Gil 2007; Barboza et al. 2009; Ceballos and Perea 2014).

Other records of ethnomedical uses include: against colds, anti-catarrhal and febrifuge (León et al. 2003; Villagrán and Castro 2003), in cases of genito-urinary

complaints (Martínez and Pochettino 2004), against prolapsed, hernia, bruises, rheumatism (Barboza et al. 2009; Dadé et al. 2009; Hurrell et al. 2011), diuretic (Díaz et al. 2011), hypotensive and to treat heart diseases (Ceballos and Perea 2014).

*C. gilliesii* is one of the aromatic shrubs (of different families such as Asteraceae, Solanaceae, and Lamiaceae) called *koas* in Andean ritual traditions. These plants are burned and its smoke is an offering to the divinities in ancient ceremonies of the annual cycle. The term *koa* means 'that which is transformed into something else', referring to the transmutation of the plant into smoke (Villagrán and Castro 2003).

In northern Argentina this species is used as a condiment. In the puna region of Jujuy it is utilized for seasoning a traditional food called *pire*, made with corn flour and water. In the Yungas of southern Bolivia and northwestern Argentina, it is used to flavor *diana*, a preparation based on boiled milk, sweetened with sugar or cane honey, to which alcohol and different aromatic herbs are added (Hilgert 1999; Vignale and Gurni 2003; Alonso and Desmarchelier 2005; Giménez and Vignale 2013).

## 9 Modern Medicine Based on Its Traditional Medicine Uses

Traditional medicinal uses related to gastrointestinal disorders have not been well enough studied from an experimental point of view. However, their effects against these disorders are linked to its content in essential oils, e.g. piperitone has been reported to possess strong enterobactericidal activity, and piperitenone oxide has been reported to be a relaxant of the intestinal smooth muscle (Sousa et al. 1997; Dambolena et al. 2009).

Referring to the traditional use as an aphrodisiac, this term is used to indicate both libido enhancers such as those that increase sexual activity, especially in cases of male sexual dysfunction (erectile dysfunction). This latter use has been supported by an in vitro study about smooth muscle relaxation activity (vasodilatory) on the Guinea pig *corpus cavernosum*, probably due (at least in part) to its phenolic compounds (Hnatyszyn et al. 2003; Singh et al. 2013). Other uses mentioned above related to reproductive medicine have not yet been evaluated.

The trials of antimicrobial, antioxidant and cytotoxic activities of this species are promising for modern medicine. The antibacterial effect of its essential oil and flavonoids was analyzed (Hernández et al. 2000; Feresin et al. 2001; Alonso and Desmarchelier 2005; Luna et al. 2008; Momtaz and Abdollahi 2008; Mattos Cortegana et al. 2013). The antifungal activity of the essential oil was also evaluated (Zygadlo and Grow 1995; Lima et al. 2011). Organic and aqueous extracts showed a trypanocidal effect in vitro (Sülsen et al. 2006; Sülsen 2012; Tepe 2015), in relation to the piperitone and piperitona oxide components. Its antiplasmodial activity was also checked (Debenedetti et al. 2002; van Baren et al. 2006). The essential oil showed properties as an insect repellent, including *Triatoma infestans*, vector of Chagas disease (Tepe 2015), and as anti-head lice (Toloza et al. 2010).

The antioxidant activity has been analyzed by different authors (Desmarchelier et al. 1997; Barboza et al. 2009; Dadé et al. 2009; Cabana et al. 2012, 2013).

Toxicity studies by bioassay of *Artemia salina* from the aqueous extract of the aerial parts of *C. gilliesii* gave a positive result for a concentration of 10 mg/ml, limit value for distinguishing toxic and non-toxic aqueous extracts. On the one hand, this result could be useful in the search for new antitumor compounds (Mongelli et al. 1996). On the other hand, also due to this result the infusion intake for long periods (and preventively during pregnancy and lactation) is not recommended. By contrast, the usual infusion doses are generally well tolerated, except some recorded cases of digestive intolerance and headaches (Alonso and Desmarchelier 2005; Hurrell et al. 2011).

*Clinopodium odorum* has also been found to show antibacterial action (Mahady 2005; Vazquez et al. 2014), and cytotoxic effect on *Artemia salina* (Mongelli et al. 1996). *Clinopodium bolivianum* have antifungal, anti-inflammatory, and cytoprotective activity (Barboza et al. 2009), anti-*Helicobacter pylori* effect, responsible for gastro-duodenal diseases (Claros et al. 2007), antiviral activity against herpes simplex type I, and vesicular stomatitis virus (Abad et al. 1999; Momtaz and Abdollahi 2008).

## 10 Conclusions

*C. gilliesii*, muña muña, is a South American species utilized for centuries in the Andean region for medicinal purposes and as food condiment, mainly due to its essential oil content. Its most widespread traditional medicinal uses are: aphrodisiac, against gastrointestinal disorders, and mountain sickness, among others. Many of these popular applications need scientific validation. Nevertheless, several studies have already checked out some important properties, such as its effect against erectile dysfunction (linked with its aphrodisiac use), enterobactericidal and intestinal smooth muscle relaxant (related with its use in treating gastrointestinal ailments), antibacterial, antifungal, trypanocidal, antiplasmodial, insect repellent (e.g. *Triatoma infestans*, the vector of Chagas disease), anti-head lice, and antioxidant. Its cytotoxic activities have also been studied. These are promising in the search for anticancer compounds.

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