Nutritional composition, antioxidant activity and isolation of scopoletin from *Senecio nutans*: Support of new and ancestral uses

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Continuing with our study about the characterization of *Senecio nutans* Sch. Bip., we have isolated and identified a simple coumarin, scopoletin, that could be relevant for the biological properties of the species related with the ancestral medical uses. This is the first report of scopoletin from *S. nutans*. In addition, was analyzed for its antioxidant activity using the ABTS and FRAP method as well providing the first nutritional analyses of this plant from northern Chile highlands.

Keywords: *Senecio nutans*, scopoletin, nutritional composition, antioxidant activity, ethnopharmacology.

1. Introduction

New plant-based health foods, nutraceuticals and botanicals have been developed from a wide range of species (Bernal et al. 2011, Heinrich and Prieto 2008), but the potential of Chilean plants remains underexplored. In the highlands of northern Chile, inhabitants have a variety of vegetal species with ancestral uses due its beneficial characteristics (Castro and Villagrán, 2004). One of these species is *Senecio nutans* Sch. Bip. (syn.: *S. graveolens* Wedd), locally known as *chachacoma*, *chachacoma del campo, chachacoma del cerro, tola, tola hembra*, which grows 3000 meters above sea level (m.a.s.l.) and is widely used by the local Andean communities for mountain sickness characterized by symptoms such as headache, dizziness, vomiting and fatigue (Castro and Villagrán 2004, Martínez *et al*. 2006). In continuation with our phytochemical investigation of *Senecio nutans*, here we report, the nutritional composition, antioxidant activity and the isolation of a compound corresponding to a coumarin derivative found in other *Senecio* specie (Dupre *et al*. 1990), but never in *S. nutans*.

2. Results and discussion

The powdered plant was analyzed for proximate composition by AOAC methods (AOAC 2005). The parameters determined were moisture (8.70%), total ash (7.19%), total lipids (14.31%), crude protein (8.18%), and crude fiber (13.23%). These values are slight compared with other medicinal plants studied, such variation might have resulted from extreme environment growing conditions of *S. nutans* (Alonso-Amelot 2008). Lipid concentration in *S. nutans* is significantly higher in comparison to other medicinal plants, presenting contents between 1% and 4%. Despite the high fat content in this plant, which is a potential nutritional risk, the antimicrobial activity of the essential oil showed effect against *Micrococcus luteus*, and *Staphylococcus aureus*, also antifungal effect on *Candida albicans* (Pérez *et al*. 1999). The total carbohydrate (57.09%) was calculated by difference with the other parameters. Carbohydrates represent the major component measured in *chachacoma*, giving a significant nutritional value to this herb. Accumulated carbohydrate reserves function as a source of monosaccharides that are used during growth and development of the plant, especially for primary and secondary metabolism of high levels of non-structural carbohydrates (free sugars, starch and fructan) that may be associated with bioactive secondary metabolites, such as flavonoids and phenols (Ibrahim *et al*. 2010).

The content of macro and micronutrients showed that the main elements are: potassium (2130 ± 0.01 mg/100g), calcium (1390 ± 0.02 mg/100g), magnesium (290 ± 0.02 mg/100g), phosphorus (230 ± 0.11 mg/100g), sodium (190 ± 0.01 mg/100g), iron (10.41 ± 0.29 mg/100g), manganese (8.48 ± 0.24 mg/100g), copper (1.18 ± 0.03 mg/100g), and zinc (0.67 ± 0.03 mg/100g). In addition, the iron content found in *chachacoma* was higher in comparison with other *Senecio* species investigated (Ajiboye *et al*. 2013). This is an important nutritional fact since studies indicated that iron is involved in pivotal processes such as erythropoiesis and intracellular oxygen transport reactions. In fact, its deficiency leads to behavioral changes and biochemical changes in the brain (de Oliveira *et al*. 2001). In this study, we assessed the polyphenolic profile of aerial parts of *S. nutans* evaluating its antioxidant capacity and the total phenolic and flavonoid content. The aerial parts were extracted with ethanol. Antioxidant capacity was measured and correlated with the total phenolic and flavonoid contents. The total phenolic and flavonoid contents, the extraction yield and antioxidant capacity measured by FRAP and ABTS are given in Table S1. The flavonoid content of *chachacoma* extract forms about 72% of its total phenolic content (Table S1). This plant had higher total polyphenols content (20.58 ± 0.59 mg GAE/g DW) compared to other Andean plants (Chirinos *et al*. 2013). Recent studies indicate that phenolic compounds in medicinal plants possess significant antioxidant efficacy and powerful scavenging activity against free radicals (Jaberian *et al*. 2013). In this case the total antioxidant activity was performed using electron transfer methods, such as ABTS and FRAP assays. The *chachacoma* extract showed a FRAP value (27.65 ± 0.06 µmol TE/g DW), slightly less when compared to those reported for other medicinal plants (Simirgiotis, Quispe, Bórquez, *et al*. 2016, Simirgiotis, Quispe, Mocan, *et al*. 2016), while *S. nutans* ABTS values for aerial parts extract (13.01 ± 0.08 µmol TE/g DW) were higher than medicinal plants like *Amaranthus caudatus* (Kiwicha), *Chenopodium quinoa* (Quínua), among others (Chirinos, Pedreschi, Rogez, Larondelle and Campos 2013). Finally, from the ethanolic extract, using column chromatography, we isolated and identified 7-hydroxy-6-methoxy-2*H*-chromen-2-one, also known as scopoletin, according to the method described by Islam *et al*. (Islam et al. 2013). This compound is also known as a constituent of many different medicinal plants (Elgamal *et al*. 1993) and has been intensely investigated as a reversible and selective MAO inhibitor (Basu *et al*. 2016) and an inhibitor of acetylcholinesterase (AChE), butyrylcholinesterase (BChE), and βsite amyloid precursor protein cleaving enzyme 1 (BACE1), relevant for anti-Alzheimer effects (Ali *et al*. 2016). The NMR assignments are in agreement with the ones reported in the literature (San Martín *et al*. 1980). It is interesting the existence of this coumarin in *S. nutans* because it supports and presents a rational explanation for the use of this ancestral plant and its traditional use for the cure of the mountain sickness for its vasodilator effect. (Elgamal, Shalaby, Duddeck and Hiegemann 1993, Ruphin *et al*. 2016).

In conclusion, this work presents the first report of the isolation of scopoletin from *Senecio nutans* related with ancestral medicinal uses in northern Chile, and the antioxidant activity of the extract can be consider for new uses of this native plant.

Supplementary material

Experimental details and table relating to this study are available online.

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