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RESEARCH PAPER

Nutritional and functional characterization of wild and cultivated *Sarcocornia neei* grown in Chile

Javiera Riquelme[1], José Antonio Olaeta[1], Lena Gálvez[2], Pedro Undurraga[1], Claudia Fuentealba[1], Andrea Osses[3], Jaime Orellana[3], José Gallardo[3], and Romina Pedreschi[1]

[1]Pontificia Universidad Católica de Valparaíso, Facultad de Ciencias Agronómicas y de los Alimentos, Escuela de Agronomía. Calle San Francisco s/n, Quillota, Chile.

[2]Pontificia Universidad Católica de Valparaíso, Facultad de Ciencias Agronómicas y de los Alimentos, Escuela de Alimentos. Av Waddington 716, Playa Ancha, Valparaíso, Chile.

[3]Pontificia Universidad Católica de Valparaíso, Escuela de Ciencias del Mar, Ave. Altamirano 1480, Valparaíso, Chile.

Abstract

J. Riquelme, J.O. Olaeta, L. Gálvez, P. Undurraga, C. Fuentealba, A. Osses, J. Orellana, J. Gallardo, and R. Pedreschi. 2016. Nutritional and functional characterization of wild and cultivated *Sarcocornia neei* grown in Chile. Cien. Inv. Agr. Cien. Inv. Agr. 43(2): 283-293. *Sarcocornia neei* is a halophyte that grows on the coast of the Valparaiso Region of Chile. Studies related to its nutritional and functional value under wild and cultivated conditions are not available. Thus, in this study, a nutritional (complete proximal, mineral and dietary fiber analysis) and functional characterization (total phenolics, β-carotene, hydrophilic and lipophilic antioxidant activity (HAA and LAA) and ascorbic acid) were performed for wild and cultivated plants. Wild plants displayed higher amounts of compounds involved in stress defense mechanisms such as total phenolics, proteins, dietary fiber and ash. The mineral analysis revealed that Na^+ and Cl^- are the main ions accumulated in wild and cultivated *Sarcocornia neei* that are present in significantly higher amounts in the cultivated plants. The functional characterization revealed higher amounts of dietary fiber, total phenolics and HAA in wild plants than in cultivated plants. Similar contents of β-carotene, LAA and ascorbic acid were found for wild and cultivated plants. The results from this study provide information on the potential of *Sarcocornia neei* to be consumed as a leafy green vegetable with important amounts of main nutrients and functional metabolites.

Key words: antioxidant, dietary fiber, proximal analysis, seawater, sustainability

Introduction

Globalization and the standardization of food production systems worldwide threatens food diversity, a phenomenon known as ´nutrition transition,´ and it has resulted in simplified diets that have replaced plant and animal food sources with a limited number of highly caloric foods. This phenomenon is highly correlated with the increase in chronic diseases such as diabetes, obesity, and cancer (Johns and Eyzaguirre, 2006).

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Corresponding author: romina.pedreschi@pucv.cl

The introduction of a diet of non-conventional plant-based foods with desirable nutritional and functional components that can be produced using non-scarce inputs (seawater, aquiculture waste and/or poor soils) is an innovative strategy to diversify and increase food availability. Halophytes are plants that can grow in areas exposed to high salinity such as seawater-immersed areas (Flowers and Colmer, 2008). Some species of halophytes have been used as forage (Bustan *et al.,* 2005), in phytoremediation (Manousaki and Kalogerakis, 2011), as a renewable energy source (Eganathan *et al.,* 2006), as ornamental plants (Zia *et al.,* 2008), and as gourmet vegetables (Ventura *et al.,* 2011).

Sarcocornia neei, known as ´sea asparagus´, is a halophytic perennial shrub that belongs to the Amaranthaceae family (former Chenopodiaceae). It grows in erect or horizontal form, and the green and succulent shoots reach 0.2 m in height (Scott, 1978). Due to the limited number of studies related to the nutritional and functional potential of *Sarcocornia*, it is often compared or associated with *Salicornia*. These two genera present similar morphological characteristics and mainly differ in the growth habit, e.g., perennial vs. annual for *Sarcocornia* and *Salicornia*, respectively (Davy *et al.,* 2006). Important amounts of crude protein (21.5–24% DW), ascorbic acid (6 mg 100 g^{-1} FW) and β-carotene (15.96 mg 100 g^{-1} FW) comparable with the amounts present in leafy vegetables such as spinach (Proteggente *et al.,* 2002) have been reported for *Salicornia* by Lu *et al.* (2010). The total polyphenol content of different species of *Sarcocornia* (2 mg GAE g^{-1} FW) (Ventura *et al.,* 2011) is higher than that of frequently consumed leafy vegetables that are considered to have a high total polyphenolic content (values>0.5 mg GAE g^{-1} FW) (Isabelle *et al.,* 2010). Both *Sarcocornia* and *Salicornia* are rich sources of polyunsaturated fatty acids (α-linolenic, ω3 and α-linoleic, ω6) with approximate values of 2.2 and 1.73 g 100 g^{-1} DW, respectively. A significant amount of ions is accumulated by the plant especially Na^+ and Cl^- with values of 1.6 and 2.6 g 100 g^{-1} fresh edible tissue (Ventura *et al.,* 2011).

To the best of our knowledge, there is no complete study to date reporting the nutritional and functional potential of the species *S. neei* present in South America. Thus, the main aims of this research were (i) to characterize nutritionally the aerial succulent shoots of *S. neei* grown in wild and cultivated conditions and (ii) to conduct a functional characterization of the aerial succulent shoots of wild and cultivated *S. neei* grown in the Valparaiso region of Chile.

Materials and methods

Plant material and growing conditions

Wild *S. neei* material was collected from Salinas de Pullally (Valparaíso, Chile; latitude, 32°24´50.72´´S; longitude, 71°23´35.01´´W) with an average temperature of 13-22 °C, annual precipitation of 315 mm, 10-14.3 h d^{-1} light and relative humidity of 44-82% (Viña del Mar Airport Weather Conditions). Aerial succulent shoots (1 kg per biological replicate) of approximately 10 cm were cut and immediately frozen in liquid nitrogen and stored at -80 ˚C. In total, 2500 cuttings of *S. neei* with a lignified base were placed in expanded polystyrene trays and destined to develop roots in seawater tanks for 4 weeks. Then, the cuttings were transplanted to boxes (70 × 70 × 30 cm) containing soil from Laguna Verde and irrigated with 20 L d^{-1} of seawater. These boxes were placed under a plastic semitransparent roof. The chemical characterization of the seawater and soil was performed by the Soil Laboratory of Pontificia Universidad Católica de Valparaíso, Chile. Forty-eight plants were symmetrically arranged in each box (67 plants m^{-2}). After 17 weeks, cultivated plants 10–15 cm in height grown at average temperatures of 13–22 ˚C and 44-82% relative humidity (Viña del Mar Airport Weather Conditions) were cut and immediately frozen in liquid nitrogen for further characterization. A total of four biological replicates comprising 35 shoots were collected for each, the wild and cultivated material.

Nutritional characterization

Proximal analysis. The proximal analysis included (g 100 g^{-1} FW) moisture (AOAC, 1984)), protein (AOAC, 1984), lipids (AOAC /NC 14019 (1984) modified), ash (AOAC, 1990), crude fiber (Schmidt-Hebbel, 1981), nitrogen-free extract (NFE) by difference and calories.

Mineral analysis. The mineral analysis of the edible wild and cultivated shoots included N (g 100 g^{-1} FW), Pb, Cd and As (mg kg^{-1} FW) according to the methods described by Sadzawka *et al.,* (2007). P, K, Ca, Mg, Na (g 100 g^{-1} FW), Zn, Mn, Fe, Cu, and B (mg kg^{-1} FW) was determined according to the methodology described by Sadzawka *et al.* (2004). Cl^- (g 100 g^{-1} FW) was determined with the method of Sadzawka (2006).

Dietary fiber. Dietary fiber was determined according to the official method AOAC 985.29 (1997) with some modifications. Dried samples were ground and passed through a mesh screen. One gram of sample was weighed in a beaker. A phosphate buffer (pH = 6.0) was added to each beaker and mixed. Then, α-amylase was added, and the beaker was placed in a boiling water bath. Subsequently, the pH was adjusted to 7.5. A protease solution was added and placed in a water bath with agitation. The pH was adjusted to 4–4.6, and amyloglucosidase was added and placed in a water bath with agitation. Then, 95% ethanol was added, and the solutions were placed overnight. Subsequently, the solution was vacuum filtered and the residue was washed with 78% ethanol, 95% ethanol and acetone. Finally, the papers were dried. The results are expressed as g dietary fiber 100 g^{-1} of sample in DW.

Functional characterization

Total phenolics (TP). Total phenolics were determined according to the method of Shetty *et al*. (1995). Samples were extracted and prepared according to the method of Chen *et al*. (2008) with some modifications and also used to test the HAA. Briefly, a dried sample was homogenized with 95% methanol and shaken. The solution was centrifuged, and the supernatant was removed to another container, shaken and centrifuged twice with 80% methanol. The methanol was evaporated by rotary evaporation. The extract was re-suspended with distilled water, and the pH was adjusted to 7. Five hundred µL of *Sarcocornia* extract was transferred into a test tube and mixed with 95% ethanol and water. Folin−Ciocalteu reagent (1 N) was added to each sample, which was then vortexed. After 5 min of dark incubation, 5% Na_2CO_3 was added, and the mixture was allowed to stand for 1 h in the dark. The absorbance was read at 725 nm. The standard curve was established using 10 to 200 µg mL^{-1} of gallic acid in 95% ethanol, and the results are expressed as mg of gallic acid equivalents (GAE) 100 g^{-1} of sample in DW.

ß-carotene. β-carotene was determined according to the methodology described by Reyes *et al*. (2007) with some modifications. The extract sample was also used to test the LAA. Carotenoids were extracted from the sample by homogenizing with acetone:ethanol (1:1) containing BHT (butylated hydroxytoluene). The homogenate was filtered and washed with the solvent and diluted using the extraction solvent. Then, hexane was added, shaken and allowed to stand for 15 min, and water was added and shaken; separation of the phases was allowed to occur for 30 min. The spectrophotometer was blanked with hexane, and the absorbance of samples was measured at 470 nm. β-carotene was quantified using a β-carotene standard curve (1–4 µg mL^{-1}). The results are expressed as mg β-carotene g^{-1} of sample in DW.

Hydrophilic and lipophilic antioxidant activity. DPPH (2,2-diphenyl-1-picrylhydrazyl) HAA and LAA were determined according to the methods of Chen *et al*. (2008) and Reyes *et al*. (2007), respectively, with some modifications. Samples were analyzed in triplicate. A work

solution (2.5 mg DPPH 100 mL^{-1} methanol) was added to the sample extract. The decrease in the absorbance was monitored after 25 min at 517 nm. The absorbance of a control (water and methanol for HAA and LAA, respectively) was also recorded after 25 min at the same wavelength. The percentage of inhibition was calculated, and the antioxidant capacity is expressed as µmol Trolox equivalents (TE) 100 g^{-1} sample DW using a standard curve of Trolox in methanol 20 - 160 µM mL^{-1}.

Ascorbic acid content. Ascorbic acid was extracted according to Odriozola-Serrano *et al.* (2007). Briefly, lyophilized samples (0.1 g) and 4.5% metaphosphoric acid were homogenized. The samples were centrifuged and vacuum filtered. A HPLC system series 200 with a UV/vis detector (Perkin-Elmer Inc., Shelton, CT, USA) equipped with a binary pump and an autosampler and controlled by TotalChrom software (Perkin-Elmer Inc., Shelton, CT, USA) was used. The analytical column was C_{18} Spherisorb ODS2 (5 µm; 4.6 mm × 250 mm) (Merck, Darmstadt, Germany). The injection volume was 20 µL, the flow rate was 1 mL min^{-1}, and the eluates were monitored at 245 nm at 20 ºC. The mobile phase comprised 0.1 M sodium acetate (pH = 4.25). Standard solutions of ascorbic acid (Sigma Chemical Co.) were prepared in concentration levels from 0.6 to 30 µg mL^{-1}. The results are expressed as mg of ascorbic acid per g of sample DW.

Statistical analysis

A completely randomized design was used, and it comprised two treatments (wild *vs* cultivated) with four biological replicates each. The data were analyzed by a *t*-test comparison of independent means using the statistical program Minitab 17. Differences were considered significant at $P \leq 0.05$.

Results

Proximal analysis

The moisture and protein contents were significantly higher in wild plants ($P \leq 0.05$) than in cultivated plants while lipids, NFE and calories displayed no significant differences. The ash and crude fiber content were significantly higher in cultivated plants ($P \leq 0.05$) than in wild plants (Table 1).

Mineral analysis

Macronutrients: Cl, Na, K, N, and Mg were observed as major minerals. Fe and Mn were observed as major micronutrients. The contaminants Cd, Pb and As were found in wild and cultivated plants but in different amounts. The Cd and As values were under the maximum values determined by the sanitary regulation of food from Chile, but Pb was beyond the limits (Adiveter, 2005).

Table 1. Proximal analysis of wild and cultivated *Sarcocornia neei* plants grown in Valparaíso.

	Wild plants		Cultivated plants	
	FW	DW	FW	DW
Moisture (g 100 g^{-1})	89.78 ± 1.30 a	-	86.96 ± 1.05 b	-
Proteins (g 100 g^{-1})	1.38 ± 0.18 a	13.50	0.91 ± 0.04 b	6.98
Lipids (g 100 g^{-1})	0.11 ± 0.06 a	1.08	0.14 ± 0.04 a	1.07
Ash (g 100 g^{-1})	3.66 ± 0.20 a	35.81	4.66 ± 0.11 b	35.74
Crude Fiber (g 100 g^{-1})	1.02 ± 0.36 a	9.98	2.21 ± 0.23 b	16.95
NFE (g 100 g^{-1})	4.05 ± 1.01 a	39.63	5.14 ± 0.83 a	39.42
Calories in 100 g	22.74 ± 3.57 a	222.50	25.41 ± 3.70 a	194.86

Data are expressed as the means of four repetitions. Different letters in vertical columns indicate significant differences ($P \leq 0.05$).

All of the minerals were found to be significantly higher in wild plants compared with cultivated plants corresponding to N, K, Ca, Mg, Mn, Pb and As (Table 2). Similar contents of P, Zn, Fe, Cu and Cl were found for both wild and cultivated plants while higher B, Na, Cd contents were found in cultivated plants than in wild plants (Table 2).

Functional characterization

The dietary fiber, total phenolics and HAA levels in wild plants were considerably higher than in cultivated plants of *S. neei*. The β-carotene, LAA, and ascorbic acid levels were found to be similar in wild and cultivated plants, with no significant differences (Table 3).

Discussion

Nutritional characterization

S. neei can be considered as a potential leafy vegetable species due to its high water content and composition as shown in the proximal analysis (Table 1). Its water content (85.95) is comparable with that of other common green leafy vegetables (94.91) such as celery, parsley, cabbage and lettuce (Caunii *et al.,* 2010). Exposure to salinity increases the succulence of plants such that ions accumulate in vacuoles, and the Na^+ in the cell may act as an effective osmotic adjuster to maintain cell turgor, promoting plant growth (Khan *et al.,* 2001). Wild plants showed a significant higher water content ($P \leq 0.05$) in the aerial tissue than the cultivated plants (86 and 89 g 100 g^{-1}, respectively). This difference could be explained by the different habitats where the plants grow. For example, the wild plants were harvested from covered saltwater wetland; therefore, the plants were constantly provisioned with salt, and the tissues were overloaded with Na^+. In addition, the water in wetlands evaporates, increasing the salt concentration that remains in the medium during the non-rainy season and consequently increasing the succulence of the plant tissue. On the other side, cultivated plants were exposed to semi-controlled conditions by the implementation of an artificial roof that protected the plants against extreme temperatures, wind and rain.

Table 2. Mineral analysis (FW) of wild and cultivated *Sarcocornia neei* plants.

Nutrients	Wild plants	Cultivated plants
N (g 100 g^{-1})	1.76 ± 0.08 a	1.36 ± 0.26 b
P (g 100 g^{-1})	0.18 ± 0.02 a	0.16 ± 0.02 a
K (g 100 g^{-1})	2.03 ± 0.09 a	1.55 ± 0.09 b
Ca (g 100 g^{-1})	0.63 ± 0.07 a	0.53 ± 0.05 b
Mg (g 100 g^{-1})	1.13 ± 0.16 a	0.82 ± 0.08 b
Zn (mg kg^{-1})	28.48 ± 4.71 a	40.98 ± 9.80 a
Mn (mg kg^{-1})	100.38 ± 18.27 a	42.00 ± 16.09 b
Fe (mg kg^{-1})	334.75 ± 113.49 a	276.25 ± 84.12 a
Cu (mg kg^{-1})	17.20 ± 5.86 a	16.7 ± 4.62 a
B (mg kg^{-1})	25.40 ± 2.87 a	33.33 ± 1.50 b
Cl (g 100 g^{-1})	15.58 ± 0.73 a	15.00 ± 1.95 a
Na (g 100 g^{-1})	8.07 ± 0.47 a	10.01 ± 0.69 b
Cd (mg kg^{-1})	0.04 ± 0.08 a	0.32 ± 0.15 b
Pb (mg kg^{-1})	12.33 ± 0.64 a	9.72 ± 0.93 b
As (mg kg^{-1})	0.22 ± 0.08 a	0.01 ± 0.00 b

Data are expressed as the means of four repetitions. Different letters in vertical columns indicate significant differences ($P \leq 0.05$).

Table 3. Functional characterization of wild and cultivated *Sarcocornia neei* plants.

	Functional characterization	
Analysis	Wild plants	Cultivated plants
Dietary fiber (g 100 g^{-1} DW)	26.98 ± 0.03 a	15.88 ± 0.06 b
Total phenolics (mg GAE g^{-1} DW)	6.13 ± 0.24 a	2.85 ± 0.24 b
β-carotene (mg g^{-1} DW)	0.47 ± 0.06 a	0.46 ± 0.03 a
Hydrophilic AC (μmoles TE g^{-1} DW)	33.4 ± 4.51 a	11.42 ± 1.36 b
Lipophilic AC (μmoles TE g^{-1} DW)	1.81 ± 0.39 a	1.87 ± 0.37 a
Ascorbic acid (mg g^{-1} DW)	0.55 ± 0.06 a	0.9 ± 0.54 a

Data are expressed as the means of four repetitions. AC=antioxidant capacity. Different letters in vertical columns indicate significant differences (P≤0.05).

The nutritional profile of wild *S. neei* substantially changed with seawater cultivation, displaying higher contents of ash and crude fiber but lower protein content (Table 1). Crude fiber in both cases (wild and cultivated) was higher than in *Salicornia* (Lu *et al.,* 2010). Increasing salinity level in the water tended to decrease the crude fiber (Ashour *et al.,* 1999). During the non-rainy season, the wild plants are exposed to higher salinity levels than seawater due to water evaporation resulting in increased NaCl concentration.

The ash content in the aerial tissue of wild and cultivated plants was high. The results obtained in our study (35.81 and 35.74 g 100 g^{-1} DW for wild and cultivated plants, respectively) were higher than the ash values reported for some other species of *Sarcocornia* found in Brazil (24.98 - 31.85 g 100 g^{-1} DW) (Bertin *et al*., 2014). The cultivated plants accumulated more minerals (Table 2) than the wild plants probably because the cultivated plants had 20 L d^{-1} irrigation; the permanent income of saline water maintained a continuous availability of minerals for plants that allowed greater absorption of Na^+. On the other hand, the wild plants were exposed to rainy seasons, which decreased the salinity in the soil, and non-rainy seasons, which increased the salinity.

The amount of protein (13.50 and 6.98 g 100 g^{-1} DW for wild and cultivated plants, respectively) as a leafy vegetable was low compared with cabbage, lettuce and parsley (16.18, 31.83, and 24.17 g 100 g^{-1} DW, respectively) (Caunii *et al.,* 2010). The protein content was higher in wild plants than in cultivated plants (Table 1). Previously, an increased protein content in plants grown under high salinity was reported (Parks *et al.,* 2002). Protein biosynthesis can be promoted as a result of stress response, inducing different changes in energy metabolism resulting in both short-term (attenuation of direct impacts of stress such as changes in osmotic potential and salt ion activity) and long-term stress adaptations (structural adaptations of plant cells that consequentially change plant growth and development (Kosová *et al.,* 2013). The synthesis of several low-molecular, highly hydrophilic organic compounds as well as high-molecular hydrophilic proteins (e.g., Late Embryogenesis Abundant (LEA) proteins) which not only decrease intracellular osmotic potential but also enhance protective properties on other cellular compounds due to salinity stress. Thus, proteins play an imminent role in plant stress response because they are directly involved in the acquisition of an enhanced stress tolerance (Kosová *et al.,* 2010). The wild plants grow under natural stress conditions such as different temperatures between seasons, coastal wind, changing soil salinity due to the rain that leaches nutrients, and root flooding. These different types of stresses probably caused an increase in protein content in the wild plants compared with the cultivated plants that were grown in a controlled environment.

The lipid content for the wild and cultivated plants did not display any significant difference (P>0.05), and the values were higher than the

values reported for spinach and lettuce (Simopoulos, 2004). Increasing the seawater concentration had no effect on the lipid content as previously reported by Ventura *et al*. (2011). The NFE content was similar to the value of 4.48% reported by Lu *et al.* (2010).

Mineral content

The mineral composition of *S. neei* is displayed in Table 2. Na^+ and Cl^- are the main ions accumulated; it is a plant that commonly grows in high-salinity environments, absorbing high amounts of minerals, especially Na^+ and Cl^- (compared with glycophytic plants), that are mainly stored in aerial tissue (Ventura *et al*., 2011). *S. neei* absorbs heavy metals; thus, it is necessary to know the soil composition where the plant is cultivated. Heavy metals are not biodegradable and therefore have the potential for bioaccumulation (Gbaruko and Friday, 2007). A mineral analysis of the soil where the wild *S. neei* grew was performed, and non-important amounts of heavy metals Cd, Pb and As (3.28, 8.35, and 0.75 mg kg^{-1}, respectively) were found according to the standards of the European Commission (2001).

The data analysis showed that the Mg^{2+}, Ca^{2+} and K^+ in cultivated plants decreased, but Na^+ increased. The Na^+ content in *S. neei* was very high compared with other green leafy vegetables (e.g., lettuce with reported Na^+ values of 0.03-0.12 g 100 g^{-1}) (Barzegar *et al.,* 2007). The permanent income of saline water in cultivated plants maintained the continuous availability of minerals for plants that allowed greater absorption of Na^+. Apparently, there are mechanisms for Na^+ transfer against other ions, but the uptake of Cl^- depends on soil salt. This mechanism consists of a vacuolar compartmentalization of Na^+ through vacuolar Na^+/H^+ antiporters and provides an efficient mechanism to avoid the negative effects of Na^+ in the cytosol and maintains the osmotic potential through Na^+ (and Cl^-) accumulation in the vacuole to drive water uptake into cells (Apse *et al.,* 1999).

The cultivated plants displayed lower contents of K^+, Mg^{2+} and Ca^{2+} than the wild counterparts. These nutrients decreased in the cultivated plants possibly as a result of the competition with Na^+ during uptake (Flowers and Colmer, 2008).

Functional characterization

The amount of dietary fiber in *S. neei* (26.98 and 15.88 g 100 g^{-1} DW for wild and cultivated plants) is comparable with that of some green leafy vegetables such as cabbage and lettuce (24.45 and 21. 68 g 100 g^{-1} DW, respectively) and a little lower than that of some other vegetables such as spinach (32.92 g 100 g^{-1} DW) (Li *et al.,* 2002). The content is nearly 40% of the vegetable tissue (Table 3) and represents a good, non-conventional source of dietary fiber (Valenzuela and Maiz, 2006). Wild plants had a considerably higher amount of dietary fiber (26.98 g 100 g^{-1} DW) than *Salicornia* species (16.5 g 100 g^{-1} DW) (Acosta-Ruiz *et al.,* 2011). The wild plants presented higher amounts of dietary fiber than the cultivated plant, possibly due to the exposure to stress conditions in its natural coastal ecosystem, which caused an increase of lignin and other structural carbohydrates (Moura *et al.,* 2010) as a defense mechanism.

The total phenolics in *S. neei* (6.13 and 2.85 mg GAE g^{-1} DW for the wild and cultivated plants, respectively) were lower than the values reported for other green leafy vegetables such as lettuce (16.9 mg GAE g^{-1} DW) (Tiveron *et al.,* 2012). The content was higher in wild plants (6.13 mg GAE g^{-1} DW) compared with that of another species of *Sarcocornia* (4.32 mg GAE g^{-1} DW) (Gargouri *et al.,* 2013). The differences between both plants (wild and cultivated) (Table 3) are probably due to the exposure to different stress conditions. According to Mamdouh *et al.* (2002), plants can synthesize and accumulate phenolic compounds in response to stress, and in their natural environments, plants are exposed to abiotic stresses. Additionally, the HAA, mainly represented by the phenolic compounds (Manach *et al.,* 2005)

was higher in wild than in cultivated plants. In natural conditions where the plant grows, the change in temperature between seasons, wind, the changing soil salinity due to rain leaching nutrients and root flooding, cause a change in the metabolism of plants, which increase their defense and therefore their antioxidant capacity. The HAA content for *S. neei* as a green leafy vegetable was lower in the wild and cultivated plants (33.4 and 11.42 µmoles TE g^{-1} DW, respectively) compared with lettuce (265.35 µmoles TE g^{-1} DW) (Wu *et al.,* 2004).

Non-significant differences in the contents of β-carotene, ascorbic acid and LAA were found between the wild and cultivated plants (Table 3). The β-carotene content (0.47 mg g^{-1} DW) as a green leafy vegetable was lower than that of lettuce (0.75 mg g^{-1} DW) (Mou, 2005). A study by Agawu (2012) showed that an increase in salinity level decreased the β-carotene content, which caused not only stomatal closure but also a decrease in stomata size and density. This effect may reduce water loss from the plants, leading to a reduction of CO_2 and light-energy intake that affects photosynthesis (Iyengar and Reddy, 1996). Compared with other ecotypes of *Sarcocornia* (0.6–0.8 mg g^{-1} DW) (Agawu, 2012), the content of β-carotene found in wild and cultivated *S. neei* was lower (0.46–0.47 mg g^{-1} DW). Agawu (2012) also reported that the ascorbic acid content declined remarkably under NaCl stress. The ascorbic acid content in *S. perennis* (8289 mg g^{-1} DW) (Gargouri *et al.,* 2013) was much higher than the values found in wild and cultivated *S. neei* (0.55-0.9 mg g^{-1} DW) and comparable with other green leafy vegetables such spinach (0.22-0.31 mg g^{-1} DW) (Favell, 1998). Finally, the LAA in wild and cultivated plants (1.81 and 1.87 µmoles TE g^{-1} DW, respectively) as a green leafy vegetable were lower than the values reported for lettuce (23.26 µmoles TE g^{-1} DW) (Wu *et al.,* 2004).

The results of cultivated plants of *S. neei* (seawater) showed that this plant could be domesticated and potentially be consumed as a green leafy vegetable with a good source of ash, crude fiber and NFE. In general, the wild plants presented higher amounts of compounds or metabolites (e.g., polyphenols, dietary fiber, and proteins) involved in defense under stress conditions (e.g., soil salinity, rain, wind, and temperature extremes). The differences are mainly structural (fiber and proteins) or due to the synthesis of antioxidant molecules (phenols, HAA). The cultivation of *S. neei* under highly stressful conditions might encourage the synthesis of valuable compounds for human health, raising the nutritional and functional value of this halophyte.

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Resumen

J. Riquelme, J.O. Olaeta, L. Gálvez, P. Undurraga, C. Fuentealba, A. Osses, J. Orellana, J. Gallardo y R. Pedreschi. Caracterización nutricional y funcional de *Sarcocornia neei* silvestre y cultivada presente en Chile. Cien. Inv. Agr. 43(2):283-293. La halófita *Sarcocornia neei* es un vegetal que crece en las costas de la V región en Chile. Estudios relacionados con su valor nutricional y funcional bajo condiciones silvestres y cultivadas no están disponibles. Por lo tanto, en este estudio se realizó una caracterización nutricional (proximal completo, análisis mineral y de fibra dietaria) y funcional (fenoles totales, β-caroteno, actividad antioxidante hidrofílica (AAH) y lipofílica (AAL) y ácido ascórbico) en las plantas silvestres y cultivadas.

En las plantas silvestres se visualizó una mayor cantidad de compuestos relacionados con el mecanismo de defensa del estrés tales como fenoles totales, proteínas, fibra dietaria y cenizas. El análisis mineral reveló que los iones mayormente acumulados son Na^+ y Cl^- en las plantas silvestres y cultivadas, siendo mayor en las plantas cultivadas. La caracterización funcional reveló una mayor cantidad de fibra dietaria, fenoles totales y AAH en las plantas silvestres que en las plantas cultivadas. Contenidos similares de β-caroteno, AAL y ácido ascórbico fueron encontrados en las plantas silvestres y cultivadas. Los resultados de este análisis proporcionan evidencia sobre el potencial de *Sarcoconia neei* para ser consumida como un vegetal de hoja verde con importantes cantidades de nutrientes principales y metabolitos funcionales.

Palabras clave: Agua de mar, análisis proximal, antioxidantes, fibra dietaria, sustentabilidad.

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