Food Chemistry 333 (2020) 127525

Contents lists available at ScienceDirect

Food Chemistry

journal homepage: www.elsevier.com/locate/foodchem

Influence of cultivation salinity in the nutritional composition, antioxidant capacity and microbial quality of *Salicornia ramosissima* commercially produced in soilless systems

Alexandre R. Lima[a], Viana Castañeda-Loaiza[b], Miguel Salazar[c], Carla Nunes[c], Célia Quintas[a], Florinda Gama[a], Maribela Pestana[a], Pedro J. Correia[a], Tamára Santos[b], João Varela[b], Luísa Barreira[b,*]

[a] MED, Mediterranean Institute for Agriculture, Environment and Development, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal
[b] CCMAR - Centre of Marine Sciences, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal
[c] Riafresh, Gambelas Business Center, Pav. E-2, Universidade do Algarve, Campus de Gambelas, Faro 8005-139, Portugal

ARTICLE INFO

Keywords:
Salicornia ramosissima
Salinity
Nutritional profile
Bioactive compounds
Antioxidant capacity
Microbial quality

ABSTRACT

The consumption of halophytes as healthy gourmet food has increased considerably in the past few years. However, knowledge on the nutritional profile of domesticated halophytes is scarce and little is known on which cultivation conditions can produce plants with the best nutritional and functional properties. In this context, *Salicornia ramosissima* J. Woods was cultivated in six different salt concentrations, ranging from 35 to 465 mM of NaCl. Both the nutritional profile, the antioxidant capacity, and microbial quality of the produced plants were evaluated including minerals and vitamins. Salt has a marked effect on growth, which decreases for salinities higher than 110 mM. Nonetheless, plants cultivated with intermediate levels of salinity (110 and 200 mM) revealed better antioxidant status with higher amounts of phenolic compounds. Overall, results from this paper indicated that soilless culture systems using low-intermediate salinities produces *S. ramosissima* plants fit for commercialization and human consumption.

1. Introduction

Halophytes are plants commonly found in saltmarshes and coastal areas worldwide. These environments pose several abiotic stresses to plants living therein including exposure to fluctuating salinities, high temperature and light intensities, and periods of drought (Lokhande & Suprasanna, 2012). Nonetheless, halophytes have developed a suit of traits, especially salt tolerance mechanisms, that give them competitive advantages over glycophyte species, in these environments (Rozema & Schat, 2013). These include increased leaf and/or stem succulence, salt exclusion, osmolyte production and also the induction of antioxidant defences (Shiri, Rabhi, Abdelly, Bouchereau, & El Amrani, 2016). In a scenario where freshwater and agricultural land are increasingly limited resources, halophytes' capacity to thrive in saline or salinized land may be an attractive alternative to conventional crops (Shabala, 2013; Ventura, Eshel, Pasternak, & Sagi, 2015). Halophytes have been used as human food for a long time and there are several reports of halophytes consumption in salads, soups, as pickles or as ingredients in bread and other foods (Panta et al., 2014). The most known example is probably quinoa (*Chenopodium quinoa*) which began as a staple food for natives in South America but is currently an exotic food present in most European markets (Adolf, Jacobsen, & Shabala, 2013). Nutritionally, halophytes are considered as good sources of proteins, fibers, minerals, vitamins but also of potent antioxidant phenolic compounds (Barreira et al., 2017; Ksouri et al., 2011). More recently, shoots of *Salicornia* spp. and *Sarcocornia* spp., halophytes belonging to Chenopodiaceae family have gained increasing interest especially from fine-dining restaurants looking for innovative ingredients for gourmet food (Barreira et al., 2017; Centofanti & Bañuelos, 2019). This has boosted research on their nutritional composition but also on the domestication of different species from these genuses due to, not only ecological reasons (e.g., to prevent abusive collection), but also to ensure food safety as these plants are known metal accumulators (Baron, Amaro, Campos, Boaro, & Ferreira, 2018).

In Portugal there are some ventures of industrial production of Salicornia in greenhouses using different cultivation methods including hydroponics. These controlled cultivation systems allow for a more uniform product which would not be possible in soil agriculture, where

* Corresponding author.
E-mail address: lbarreir@ualg.pt (L. Barreira).

https://doi.org/10.1016/j.foodchem.2020.127525
Received 25 January 2020; Received in revised form 5 June 2020; Accepted 5 July 2020
Available online 10 July 2020
0308-8146/