World Academy of Science, Engineering and Technology
International Journal of Nutrition and Food Engineering
Vol:12, No:08, 2018

Cultivation of Halophytes: Effect of Salinity on Nutritional and Functional Properties

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Abstract : In the last century, the world witnessed an exponential demographic increase that has put an enormous pressure on agriculture and food production. Associated also with climate changes, there has been a decrease in the amount of available freshwater and an increased salinization of soils which can affect the production of most food crops. Halophytes, however, are plants able to withstand high salinities while maintaining a good growth productivity. To cope with the excess salt, they produce secondary metabolites (e.g. vitamins and phenolic compounds) which, along with the natural presence of some minerals, makes them not only nutritionally rich but also functional foods. Some halophytes, as quinoa or salicornia, are already used in some countries, mostly as gourmet food. Hydroponic cultivation of halophytes using seawater or diluted seawater for watering can decrease the pressure on freshwater resources while producing a nutritional and functional food. The XtremeGourmet project funded by the EU aims to develop and optimize the production of different halophytes by hydroponics. One of the more specific objectives of this project is the study of halophytes' productivity and chemical composition under different abiotic conditions, e.g. salt and nutrient concentration and light intensity. Three species of halophytes commonly occurring in saltmarshes of the South of Portugal (Inula chrithmoides, Salicornia ramosissima and Mesembryanthemum nodiflorum) were cultivated using hydroponics under different salinities, ranging from 5 to 45 dS/m. For each condition, several parameters were assessed namely: total and commercial productivity, electrical conductivity, total soluble solids, proximal composition, mineral profile, total phenolics, flavonoids and condensed tannins content and antioxidant activity. Results show that productivity was significantly reduced for all plants with increasing salinity up to salinity 29 dS/m and remained low onwards. Oppositely, the electrical conductivity and the total soluble solids content of the produced plants increased with salinity, reaching a plateau at 29 dS/m. It seems that plants reflect the salt concentration of the water up to some point, being able to regulate their salt content for higher salinities. The same tendency was observed for the ash content of these plants, which is related to the mineral uptake from the cultivating media and the plants' capacity to both accumulate and regulate ions' concentration in their tissues. Nonetheless, this comes with a metabolic cost which is observed by a decrease in productivity. The mineral profile of these plants shows high concentrations of sodium but also high amounts of potassium. In what concerns the microelements, these plants appear to be a good source of manganese and iron and the low amounts of toxic metals account for their safe consumption in moderate amounts. Concerning the phenolics composition, plants presented moderate concentrations of phenolics but high amounts of condensed tannins, particularly I. crithmoides which accounts for its characteristic sour and spicy taste. Contrary to some studies in which higher amounts of phenolics were found in plants cultivated under higher salinities, in this study, the highest amount of phenolic compounds were found in plants grown at the lowest or intermediate salinities. Nonetheless, there was a positive correlation between the concentration of these compounds and the antioxidant capacity of the plants' extracts.

Keywords : functional properties, halophytes, hydroponics, nutritional composition, salinity effect
Conference Title : ICFND 2018 : International Conference on Food, Nutrition and Dietetics
Conference Location : New York, United States
Conference Dates : August 27-28, 2018