The Quarterly Scientific Journal of Applied Biology

Vol.37, No.1, Sering.79, Spring 2024, p. 13-15

Journal homepage: https://jab.alzahra.ac.ir

doi.org/10.22051/jab.2024.44033.1570

The Role of Chitosan on Some Physiological and Biochemical Properties and PAL Enzyme in Basil Plant (*Ocimun basilicum* L.) Under Salinity Stress

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Introduction

Chitosan is a polysaccharide that elicits numerous defense responses in plants e.g. resistance to biotic and abiotic stresses and is effective in increasing the growth rate of plants and increasing the production of secondary metabolites. Basil (*Ocimum basilicum* L.), a medical herb and an economical species of the mint family and it has many varieties in terms of morphology and secondary compounds. Considering the growing trend of salinity in the country and the risks caused by it and the importance of basil plant in the pharmaceutical and food industries, this study was conducted to investigate the role of chitosan on some physiological and biochemical properties and Phenylalanine ammonia lyase (PAL) enzyme in basil plant under salinity stress.

Material and Methods

After chitosan treatments at a concentration of 200 mg/L, plants were exposed to four levels of NaCl salinity stress, 25, 50, 100 and 150 mM. The activity of PAL enzyme, physiological and biochemical responses were investigated under the effect of the interaction between chitosan and concentrations of salinity stress. In addition, the following parameters were calculated: total phenol content using the folin-ciocalteu method, flavonoids content using aluminum chloride colorimetric technique, carotenoids and chlorophylls based on Stoeva et al., 2005, malondialdehyde content based on Health & Packer, 1986 procedure, catalase and peroxidase activity respectively based on Pereira et al., 2002 and Biles & Abeles, 1991methods, using spectrophotometry.

Result and Discussion

The results revealed that salinity stress has negative effects on the physiological parameters of basil such as total chlorophyll, the highest reduction of chlorophyll (0.42 mg/g fresh weight) was observed at the highest salinity level (150 mM). This reduction can be due to the disturbance in the absorption of essential mineral nutrients for chlorophyll biosynthesis like nitrogen and iron (Jaleel et al., 2009). In addition, chitosan at high salinity levels had a positive effect on the total chlorophyll, and at all salinity levels increased carotenoids content. Catalase and peroxidase enzymes and potassium content also increased in chitosan treatments, which indicates an increase the response of defense system to salt stress in plants. Furthermore, Chitosan increased PAL enzyme activity, as an important parameter in the biosynthesis of phenylpropanoids. On the other hand, chitosan application has a significant effect on methylcavicol content up to 55 % in medium and high salt stress (50, 100 150 mM). On the other hand, chitosan had no significant effect on methyl-eugenol in the absence of salt stress, but at all salinity levels, the use of chitosan reduced the content of methyl-eugenol.

The interaction of salinity × chitosan was not significant effect on some parameters like flavonoids and total phenol content. The malondialdehyde content increased significantly with the increase of salinity, in the presence or absent of chitosan. The highest values were recorded in the condition without chitosan application, so that at a salinity of 150 mM content of malondialdehyde increased more than 5 times compared to the control group. On the other hand, the results showed that the interaction of salinity × chitosan caused a significant decrease in malondialdehyde. Another effect of chitosan on basil was to decrease sodium and significantly increase potassium compared to the control group at all salinity levels, which maintains the ionic balance in the plant and helps to absorb water under stress conditions. Maintaining the ratio of sodium to potassium in plant tissues is necessary for osmoregulation, maintaining cell water pressure, activity of various enzymes, synthesis of proteins, oxidative metabolism, photosynthesis and opening and closing of stomata (Shabala et al., 2006). In general, it can be concluded that the role of chitosan in basil plants under salinity by maintaining the ions homeostasis causes the continuation metabolism in plant under stress conditions; therefore, the application of chitosan has an effect on the secondary compounds in basil to improve salt-stress tolerance.

Conclusions

In general, salinity stress changed the secondary metabolites of basil and led to the increase of some secondary compounds in the plant such as MDA and sodium. The use of chitosan improved some physiological and biochemical indicators such as phenol, chlorophyll, antioxidant enzymes, carotenoid, flavonoid and potassium content and effectively increased plant tolerance to stress conditions. In addition, the use of chitosan led to an increase in the activity of PAL, which ultimately resulted in an increase in the phenyl-propanoid compounds of the essential oil such as methyl-cavicol.

Keywords: Mint family, Phenylpropanoid, Sodium chloride, Malon-di-aldehyde.

Acknowledgement

This paper is a part of the first author's doctoral dissertation in the field of biology. The authors would like to express their sincere gratitude to the Islamic Azad University, Science and Research Branch Specially Biology Department and Laboratory of Agricultural Research Center for providing the necessary facilities for the implementation of this project.

Declaration of conflict of interest

The authors declare that they have no competing interests in conducting this research.

Statement on ethics

This article does not contain any studies with human or animal subjects.