Biochemistry & Pharmacology: Open Access

Singh et al., Biochem Pharmacol 2014, 3:6
DOI: 10.4172/2167-0501.1000e170

Editorial Open Access

# Proline and Salinity Tolerance in Plants

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The ever-increasing populations in developing countries like India adversely affecting the agro-ecosystem, due to unsustainable agricultural practices. The problem of salinity is of global concern but it is more conspicuous in arid and semi-arid regions of the world, which are characterized by limited rainfall, high transpiration, and high temperature [1]. Salinity affects almost every aspect of the physiology and biochemistry of plants and significantly reduces their yield [2]. Salt stress causes an imbalance of cellular ions resulting in ion toxicity (primary effect), and osmotic stress (secondary effect) while high salinity induces the production of severe toxic oxygen derivatives (ROS) such as superoxide radicals ($O_2^{\bullet -}$), singlet oxygen ($^1O_2$), hydrogen peroxide ($H_2O_2$) and consequently formation of the most toxic hydroxyl radicals ($^\bullet OH$) through fenton reaction in plants, and may interact with many essential macromolecules and metabolites causing cellular damage [3,4]. In order to protect cells and tissue from oxidative damage, plants must produce low molecular weight non-enzymatic antioxidants such as proline, glutathione and ascorbate as well as enzymatic antioxidants including peroxidase, superoxide dismutase, ascorbate peroxidase and catalase to defend against oxidative stress [3,4]. One of the efficient protection mechanisms of plant against hyperosmotic stress is the increasing endogenous level of compatible solutes such as proline, ectoine, glycine betaine and sorbitol [3]. In many plants, free proline accumulates in response to the imposition of a wide range of biotic and abiotic stresses. Most attempts have been taken into consideration on the ability of proline to mediate osmotic adjustment, stabilise subcellular structures and scavenge toxic oxygen derivatives. High levels of proline synthesized during stress conditions and also maintain the NAD(P)+/NAD(P)H ratio [5].

Proline is multifunctional amino acids and also a signalling molecule acting as a plant growth regulator by triggering cascade signalling processes [6]. Proline preferred as a common osmolyte in plants and get up-regulated against different stresses [4,7]. Its accumulation in plants provides protection against salinity and drought stress. Exogenous application of proline improves the crop tolerance against various abiotic stresses particularly salinity by protecting them from the severe effects of ROS [7]. Plants tend to enhance its endogenous level with continuously increasing levels of salinity [8]. This editorial focused on adverse impact of NaCl stress on plants, and how plants survive under salt affected land by increasing their endogenous level of proline.

The biosynthesis and degradation of proline, and its accumulation in plants is regulated by different abiotic stresses and salinity has the great concern [6]. Proline synthesis in plants consists two different cycles. First of them is glutamate cycle, in which, glutamate is phosphorylated to ϒ-glutamyl phosphate and reduced to glutamate-ϒ-semialdehyde (GSA), which is spontaneously cyclized to $\Delta^1$-pyrroline-5-carboxylate (P5C). The second is the ornithine cycle, in which ornithine is transaminated to GSA by ornithine ϒ-aminotransferase (OAT) [6]. Proline biosynthesis from glutamate consist two enzyme reactions involving $\Delta^1$-pyrroline-5-carboxylate synthetase (P5CS) and glutamate dehydrogenase (GDH). On the other hand, the proline accumulation depends on its degradation rate, which is catalysed by the mitochondrial enzyme proline dehydrogenase (PDH) [6]. In plants, both PDH and $\Delta^1$-pyrroline-5-carboxylate dehydrogenase (P5CDH) are attached to the matrix side of the inner mitochondrial membrane [5]. Proline synthesis initiates the generation of $NADP^+$, which acts as the backbone for ribose 5-phosphate required for the purines synthesis, and proline oxidation yields the reduced electron carriers, which provide energy for the numbers of biochemical reaction such as nitrogen fixation [9]. Exogenous application of proline may be a good approach to decrease the undesirable effects of salinity stress on plants [6,10] and metal stress [11]. It was also reported that, the exogenous application of proline alleviates the adverse effects of salt by reducing the accumulation of $Na^+$ and $Cl^-$ in plants [10].

Proline provides tolerance against different abiotic stresses by increasing their endogenous level and their intermediate enzymes in plants. It was also reported that, the exogenous application of proline increases the endogenous level of proline in bean (*Phaseolus vulgaris* L.) [11]. Proline regulates expression of number of genes related to antioxidant enzymes under salt stress. Among different genes, one of the gene $\Delta^1$-pyrroline-5-carboxylate synthetase is responsible for up-regulating the stress-induced proline accumulation under salinity stress [9].

Finally, salt stress imposed the severe effects on plant growth and productivity by interrupting the normal metabolic processes and the proline may alleviate the negative impact of salt by decreasing osmotic stress that consequently maintain the membrane integrity and its function. The exogenous application of proline could offer a simple and an economical approach for farmers to reduce the crop loss risk in salt contaminated land. However, further studies are needed at physiological and molecular levels to gain deeper insight in understanding interaction of NaCl induced oxidative stress and alleviation mechanism of exogenous proline in crops.

## Acknowledgement

Authors are thankful University Grants Commission, New Delhi for financial assistance. One of the authors Jitendra Kumar is also thankful to University Grants Commission, New Delhi for providing financial support as JRF under Rajiv Gandhi National Fellowship.

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**Received:** September 29, 2014; **Accepted:** September 06, 2014; **Published** September 08, 2014

**Citation:** Singh M, Kumar J, Singh VP, Prasad SM (2014) *Proline and Salinity Tolerance in Plants.* Biochem Pharmacol 3: e170. doi:10.4172/2167-0501.1000e170

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