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Influence of natural and synthetic vitamin C (ascorbic acid) on primary and secondary metabolites and associated metabolism in quinoa (*Chenopodium quinoa* Willd.) plants under water deficit regimes

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ABSTRACT

Phytoextracts are being widely used these days as a source of bioactive compounds for mitigating the harmful effects of abiotic stresses including drought stress. In this study, it was assessed how far foliar applied pure synthetic ascorbic acid (AsA) or natural sweet orange juice (OJ) enriched with AsA could mitigate the drought stress induced adverse effects on growth and some key metabolic processes in quinoa (*Chenopodium quinoa* Willd.; cultivar V_9) plants. Two weeks old quinoa seedlings were subjected to varying irrigation regimes as control [100% field capacity (FC)] and drought stress (60% FC, 40% FC and 20% FC). After one month of water deficit treatments, various levels of ascorbic acid (150 mg L^{-1} AsA or 25% OJ) besides control [distilled water (DW) and no spray (NS)] were applied as a foliar spray. After 15 days of AsA application, different physio-biochemical attributes were measured. The results showed that water deficit markedly decreased plant growth, relative water content (RWC), photosynthetic rate, total carotenoids (CAR) and total flavonoids, while it increased relative membrane permeability (RMP), intrinsic AsA content, hydrogen peroxide (H_2O_2), malondialdehyde (MDA), glycinebetaine (GB), total phenolics, total soluble proteins (TSP), total free amino acids, activities of key antioxidant enzymes [superoxide dismutase (SOD), peroxidase (POD)], total soluble sugars (TSS), reducing (RS) and non-reducing sugars (NRS). Most obvious results of most of these parameters were observed at 40% and 20% FC. Foliar-applied pure 150 mg L^{-1} AsA and 25% OJ were found to be very effective in improving plant growth, RMP, photosynthetic rate, CAR, proline, AsA, MDA, GB, TSP, free amino acids, SOD, POD, TSS, RS, NRS and total flavonoids. It was noticed that 25% OJ enriched with AsA and other essential nutrients and biomolecules was as efficient as 150 mg L^{-1} AsA in reducing the adverse effects of drought stress on quinoa plants. So, it was concluded that OJ, a cheaper source of vitamin C, can be used as a mitigating agent for improving drought tolerance in plants under drought-prone environments.