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

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9 ABSTRACT

10 Phytoextracts are being widely used these days as a source of bioactive compounds for
11 mitigating the harmful effects of abiotic stresses including drought stress. In this study, it was
12 assessed how far foliar applied pure synthetic ascorbic acid (AsA) or natural sweet orange juice
13 (OJ) enriched with AsA could mitigate the drought stress induced adverse effects on growth and
14 some key metabolic processes in quinoa (*Chenopodium quinoa* Willd.; cultivar V₉) plants. Two
15 weeks old quinoa seedlings were subjected to varying irrigation regimes as control [100% field
16 capacity (FC)] and drought stress (60% FC, 40% FC and 20% FC). After one month of water
17 deficit treatments, various levels of ascorbic acid (150 mg L⁻¹ AsA or 25% OJ) besides control
18 [distilled water (DW) and no spray (NS)] were applied as a foliar spray. After 15 days of AsA
19 application, different physio-biochemical attributes were measured. The results showed that
20 water deficit markedly decreased plant growth, relative water content (RWC), photosynthetic
21 rate, total carotenoids (CAR) and total flavonoids, while it increased relative membrane
22 permeability (RMP), intrinsic AsA content, hydrogen peroxide (H₂O₂), malondialdehyde
23 (MDA), glycinebetaine (GB), total phenolics, total soluble proteins (TSP), total free amino acids,
24 activities of key antioxidant enzymes [superoxide dismutase (SOD), peroxidase (POD)], total
25 soluble sugars (TSS), reducing (RS) and non-reducing sugars (NRS). Most obvious results of
26 most of these parameters were observed at 40% and 20% FC. Foliar-applied pure 150 mg L⁻¹
27 AsA and 25% OJ were found to be very effective in improving plant growth, RMP,
28 photosynthetic rate, CAR, proline, AsA, MDA, GB, TSP, free amino acids, SOD, POD, TSS,
29 RS, NRS and total flavonoids. It was noticed that 25% OJ enriched with AsA and other essential
30 nutrients and biomolecules was as efficient as 150 mg L⁻¹ AsA in reducing the adverse effects of
31 drought stress on quinoa plants. So, it was concluded that OJ, a cheaper source of vitamin C, can
32 be used as a mitigating agent for improving drought tolerance in plants under drought-prone
33 environments.

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