Chilling injury in citrus fruit: a holistic view

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Abstract

High paying markets require cold-sterilisation of citrus fruit as a quarantine measure against fruit fly. However, cold storage might increase the production of free radicals, therefore resulting in oxidative damage leading to chilling injury, which manifests itself as dark lesions and pitting, thereby reducing fruit marketability. The development of chilling injury as physiological disorder depends on the cellular balance between reactive oxygen species (ROS) and antioxidants, the sugar-ascorbic relationship with a supportive role played by polyamines. Therefore, the aim of this study was to develop a holistic model incorporating the roles played by sugars, proline, antioxidants, polyamines, as well as postharvest treatments to alleviate chilling injury, hot water dips (HWD) and molybdenum (Mo) dips; such treatments were designed to increase the concentration of bio-molecules involved in chilling resistance of citrus fruit. Principal component analysis (PCA) of the data led to a reduction in variation, with major contributions from ascorbic acid, total phenolics, 2,2-diphenyl-1-picrylhydrazyl (DPPH) and naringin. Furthermore, PCA showed significant differences between groupings of chilling sensitive fruit (Sun Valley Estates) compared with non-chilling susceptible fruit (Ukulinga Research Farm). In addition, 1 µM Mo, HWD at 53°C and 10 µM Mo plus HWD at 53°C were effective in mitigating chilling injury and triggering an increase in the conversion of glucose to ascorbic acid, increasing flavedo proline, antioxidants and polyamines. In conclusion, preharvest orchard practices and environmental conditions are major factors determining the chilling susceptibility of lemons.