No. 2337

Establishment of a Tomato Cultivation Technique that Maximizes the Accumulation of Vitamin C in the Early Stages of Ripening through Saltwater Cultivation with Mannose

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Summary

Fruit constituents play a significant role in determining the taste and consumer appeal of major horticultural crops. Salt stress induces osmotic stress and ion toxicity, often hindering plant growth and metabolism. However, tomatoes cultivated in saline environments under salt-stressed conditions have been observed to accumulate sugars like glucose and fructose, along with proline and γ-amino acids such as aminobutyric acid and vitamin C, resulting in commercially valuable fruits. Despite this, limited research has focused on the accumulation of highly functional compounds such as vitamin C. During the ripening stages of tomato fruit, vitamin C accumulates during saline cultivation, correlating with a decrease in the amount of mannan in the pericarp and seeds. Vitamin C shares a common biosynthetic pathway with mannan, suggesting a potential trade-off between the two for the substrate mannose. It is hypothesized that cultivation in seawater leads to a deficiency in both vitamin C and mannose, the precursor for mannan synthesis. In this study, we established a cultivation system involving mannose supplementation alongside saltwater irrigation. We analyzed the expression of the vitamin C synthase gene and found that its expression increased at the early ripening stage under salt stress conditions. Mannose also increased, and the expression of mannan synthase genes, which are involved in the synthesis and degradation of mannan, also increased significantly at the mid-ripening stage. Our results show that the immature green fruit pericarp contained nearly the same amount of vitamin C as the red, almost ripe fruit, indicating that vitamin C synthesis reaches its peak during the early ripening stage. Tomatoes are shipped in an unripe state, so a cultivation system that combines salt water and mannan is an effective method that can be transferred to agricultural technology, as unripe fruit can yield tomatoes with the same level of vitamin C content as ripe fruit.