Involvement of oligosaccharides and sucrose-related genes on sucrose retention in strawberries from ripening to shelf-life

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Abstract

Sucrose is a key player in strawberry metabolism. However, the molecular mechanisms underlying sucrose status in strawberries during later ripening stages and postharvest storage remains quite limited. Therefore, we identified members of various gene families encoding key enzymes involved in sucrose metabolism, analyzed their expression profiles and determined the sugar content in strawberries at different ripening stages and postharvest treatments. Three different ripening stages around harvest time, almost red (AR), full red (FR) and dark red (DR) were analyzed, as well as after pre-treatment with high CO_2 levels (18 % CO_2, 2 d) during low temperature (LT) storage and further shelf-life at 20 °C. The accumulation of sucrose, hexoses, trehalose, *myo*-inositol, fructo-oligosaccharides (FOS) and raffinose family oligosaccharides (RFOs) was analyzed. Our results indicate that the transition from FR to DR stages was characterized by a prominent accumulation of hexoses, sucrose and a sharp decrease in the levels of FOS. We therefore suggest that FOS, in addition to their protective role in stressful conditions, are also important metabolic signals of the end of ripening process. The highest levels of RFOs was detected in strawberries at LT in air, making them a possible marker of damage, an idea reinforced too by the low RFOs and high *myo*-inositol quantities found in high CO_2 protective treatment. Interestingly, the sucrose accumulation in fully ripe strawberries and in high CO_2-treated ones was linked to a significant decrease in the expression of *FvVIN2* (vacuolar invertase), an opposite trend to that observed in fruit stored in air. Furthermore, high levels of CO_2 prevented both the upregulation of *FvSS1* and the sharp increase in the expression of *FvCWINV1* observed at low temperature in air. The efficiency of high CO_2 pre-treatment on sucrose accumulation was particularly evident during the shelf-life period at 20 °C (SL) after LT storage. Our study provides new insights into how strawberries become sweet by retaining sucrose content. Additionally, our results clearly highlight the need to specify the sugar status at harvest to know the effectiveness of a treatment in maintaining quality attributes.