Metabolite profiling of postharvest senescence in different strawberry cultivars

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INTRODUCTION

The cultivated ***strawberry*** (*Fragaria* x *ananassa*) is the most consumed berry worldwide, being well appreciated for its delicate ***flavour*** and ***nutritional characteristics***. However, strawberries possess a very ***short postharvest shelf-life***, and its extension is a major economic goal. Measures are commercially taken to delay senescence, including the use of ***low temperature storage*** and ***controlled atmospheres*** [1].

RESULTS

1. *Principal component analysis* (PCA) showed that samples clustered by ***genotype*** rather than by postharvest treatments.

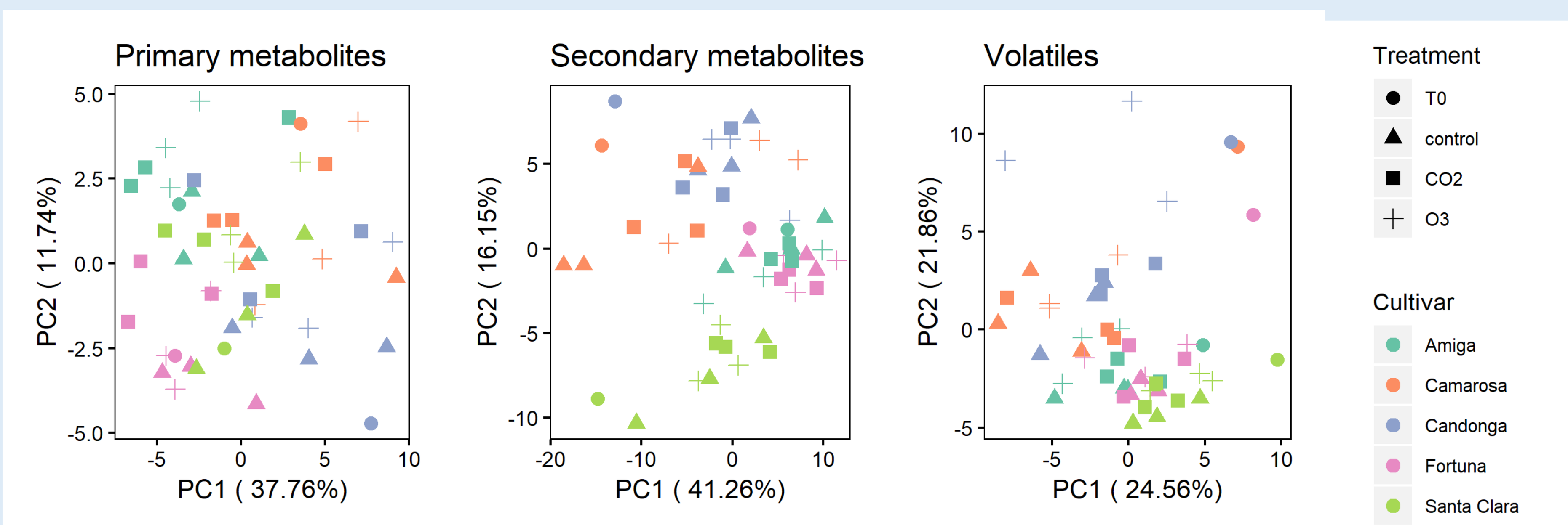
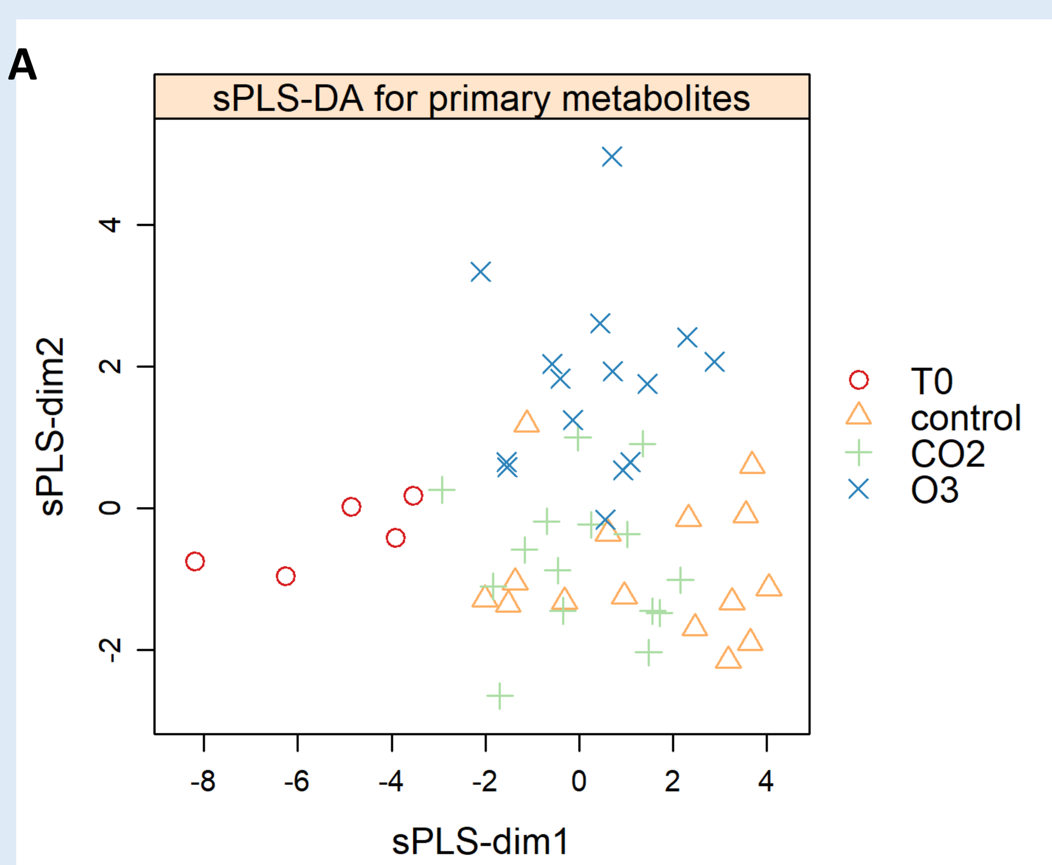


Figure 1: PCA of normalized metabolite content (expressed as z-scores) found in the postharvest samples. Fruits directly analyzed after harvest are also represented (T0 fruits). Different colors indicate the genotypes, while postharvest treatments are shown with different shapes.

2. Metabolites related to ***abiotic stress*** are able to discriminate postharvest samples from T0 fruits

A



Dimension 1 separates ripe fruits directly analyzed after harvest (T0 fruits) from the fruits kept in the 3 postharvest atmospheres.

→ γ-amino-butyric acid (**GABA**) is the most discriminative/predictive metabolite for postharvest samples, with higher content in control atmosphere.

Dimension 2 is able to separate at least partially samples kept in O_3-enriched atmosphere from control and CO_2-enriched atmosphere

→ **galactinol, fructose-, glucose-6-phosphate and succinic acid** are the most discriminative/predictive metabolites for O_3-enriched atmosphere.

B

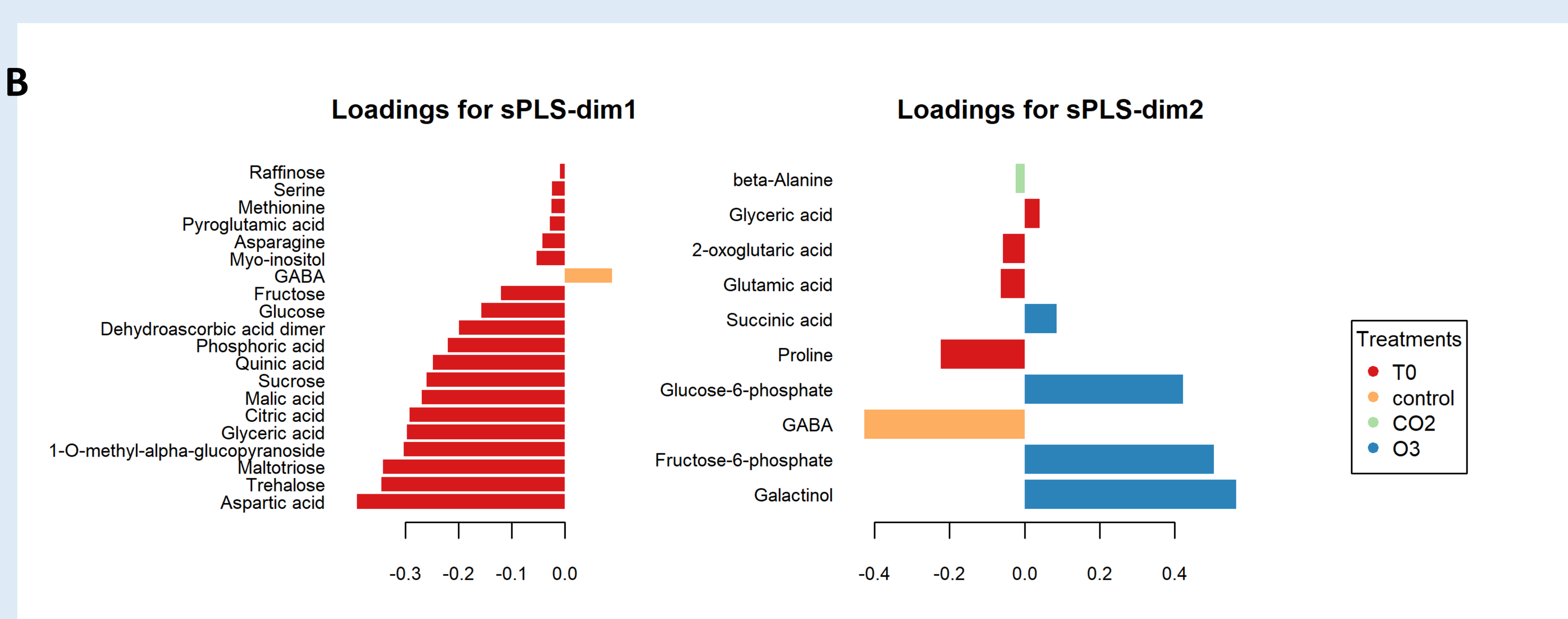


Figure 2: **A.** Sparse partial least squares discriminant analysis (sPLS-DA) of primary metabolite profiles in control, CO_2-, O_3-enriched atmospheres and in T0 fruits, using 20 and 10 metabolites for dimensions 1 and 2 (sPLS-dim1 and 2), respectively. **B.** Loadings, or contribution, of each metabolite for sPLS-dim1 and 2; the color indicates in which treatment the metabolite content is higher.

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OBJECTIVES

→ Improve our understanding of the mechanisms underlying the deterioration of fruit quality during postharvest

Amiga Camarosa Candonga Fortuna Santa Clara

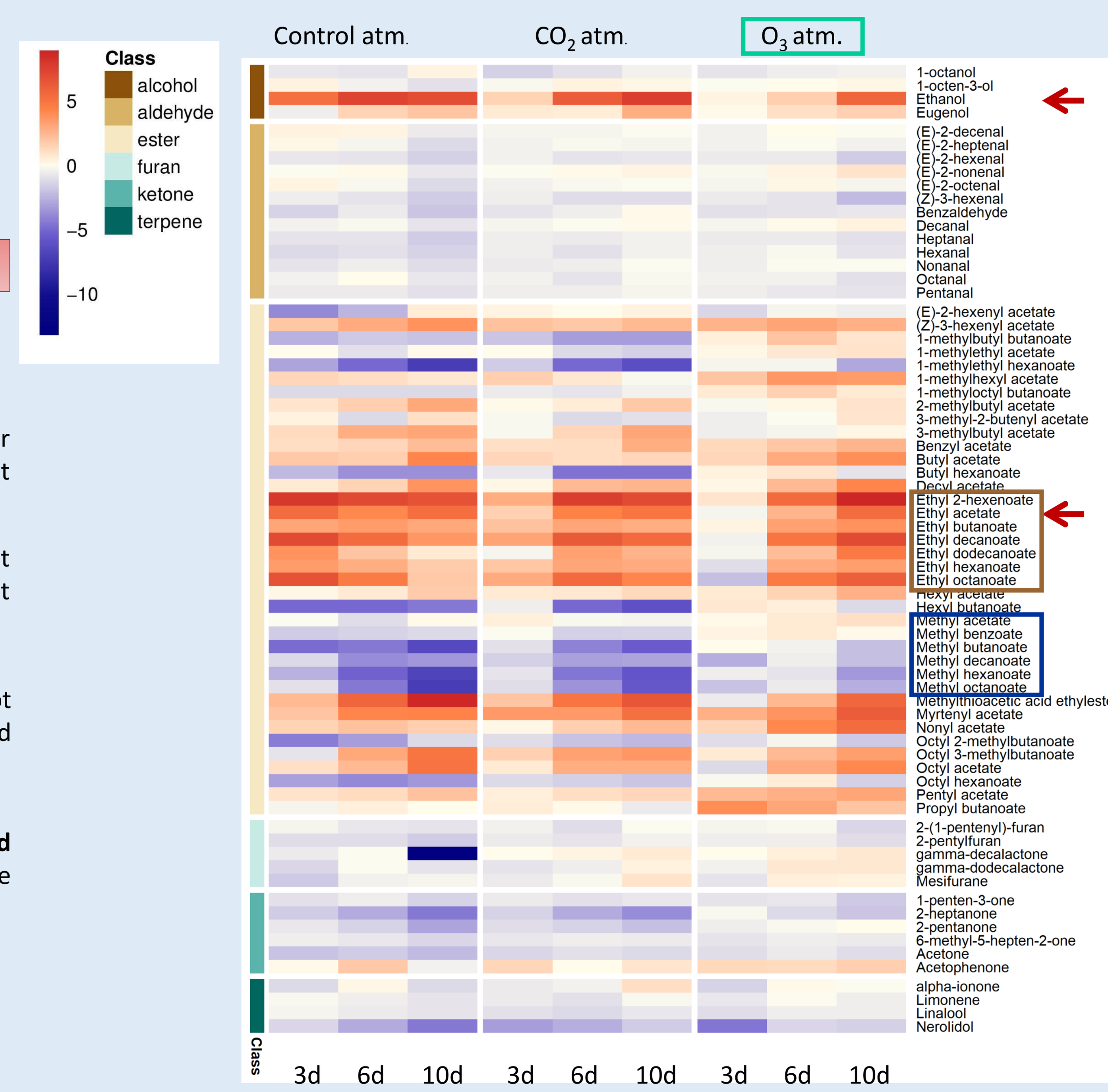
Ripe fruits were kept at 4ºC during 3, 6 and 10 days in:
→ CONTROL ATMOSPHERE ("normal" air)
→ CO_2-ENRICHED ATMOSPHERE
→ O_3-ENRICHED ATMOSPHERE

Metabolite profiling of five commercial strawberry cultivars:
→ Gas chromatography-mass spectrometry (GC-TOF-MS)
→ Ultra-performance liquid chromatography-Orbitrap mass/mass spectrometry (UPLC-Orbitrap-MS/MS)
→ Headspace solid phase micro extraction (HS-SPME) coupled with GC-MS

Identification and semi-quantification of ***49 primary metabolites***, ***132 semi-polar metabolites*** and ***70 volatiles*** involved in fruit quality traits.

Multivariate statistical analysis

3. Log2 fold change of ***volatiles*** in the postharvest samples showed some ***drastic changes***, conserved between genotypes and attenuated initially by O_3-enriched atmosphere.



Ethanol and ***ethyl acetate***, two fermentative, off-aroma compounds, are strongly increased during postharvest

Ethyl esters are increased during postharvest, possibly as a consequence of their precursor (ethanol) availability

On the opposite, ***methyl esters*** are strongly decreased during postharvest

O_3-enriched atmosphere attenuates initially volatiles changes during postharvest, including the accumulation of off-aroma compounds

Figure 3: Log2 fold change in 'Candonga' cultivar postharvest samples for volatile content, when compared to fruits directly analyzed after harvest (3, 6 and 10d indicate the duration of the postharvest treatments).

CONCLUSIONS

→ Metabolites associated with different ***abiotic stresses*** were increased in postharvest samples (**Figure 2**):

- ***GABA***: associated with oxygen deficiency and injury symptoms due to controlled atmosphere storage. Its level increases quickly under abiotic stress [2,3]
- ***Fructose-*** and ***glucose-6-phosphate***: induction due to oxidative stress in O_3-enriched atmosphere, with a possible role in ROS scavenging [4].
- ***Galactinol***: involved in cold responses, as part of the raffinose pathway (membrane osmoprotectant) [5,6].

→ O_3-enriched atmosphere seems to attenuate partially volatile changes during postharvest, including the generation of fermentative volatiles (**Figure 3,** [7]).

→ Methyl/ethyl esters are the dominating aroma compounds in ripe strawberries, being their ratio characteristic of each cultivar. They are also drastically affected by postharvest conditions, possibly impacting the aroma of strawberries once they reach the consumers.

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