Metabolomic characterization of strawberry cultivars during postharvest (*Fragaria* x *ananassa*)

Delphine M. Pott[1], Sonia Osorio[1*], José G. Vallarino[2*]

*[1]Instituto de Hortofruticultura Subtropical y Mediterránea "La Mayora", University of Malaga-Consejo Superior de Investigaciones Científicas, Department of Molecular Biology and Biochemistry, Campus de Teatinos, 29071 Málaga, Spain. [2]Max-Planck-Institute für Molekulare Planzenphysiologie, Am Mühlenberg 1, 14476 Golm, Germany. *Correspondence should be addressed to J.G.V. (vallarino@mpimp-golm.mpg.de) and S.O. (sosorio@uma.es).*

INTRODUCTION

Strawberry (*Fragaria* x *ananassa*) is the berry most consumed worldwide, being well-known 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 low temperature and controlled atmosphere (Pedreschi and Lurie, 2015).

To improve our understanding of the mechanisms underlying the deterioration of fruit quality during senescence, we monitored the metabolomic profiles of five strawberry cultivars under different postharvest treatments, and compared them with metabolomic profiles of fruits directly analyzed after harvest. Ripe fruits were kept at 4ºC during three, six and ten days in normal, CO_2 and O_3-enriched atmospheres. We used a combination of gas chromatography-mass spectrometry (GC-TOF-MS), ultra-performance liquid chromatography-Orbitrap mass/mass spectrometry (UPLC-Orbitrap-MS/MS) and headspace solid phase micro extraction (HS-SPME) coupled with GC-MS to identify and semi-quantify metabolites and volatiles involved in quality traits

RESULTS

1. Principal component analysis (PCA) based on the metabolomic data showed that samples clustered by genotype rather than by postharvest treatments.

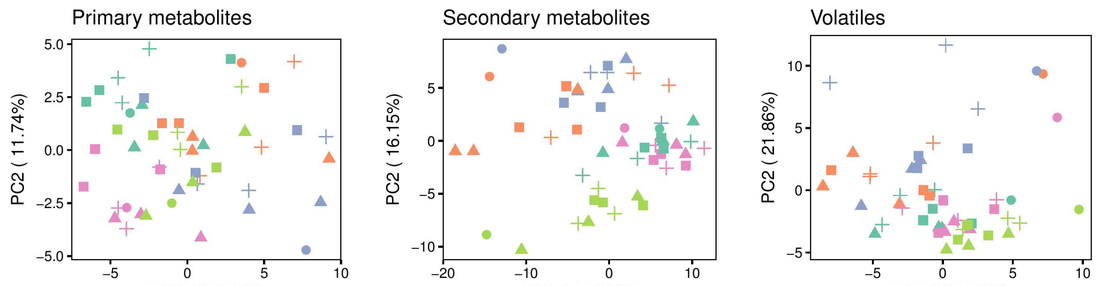

Figure 1: PCA of the primary metabolites, secondary metabolites and volatiles profiles found in the postharvest samples and their control fruits.

2. GABA, putrescine, β-alanine, galactinol, succinic acid and glycine are able to separate control samples from postharvest treated fruits.

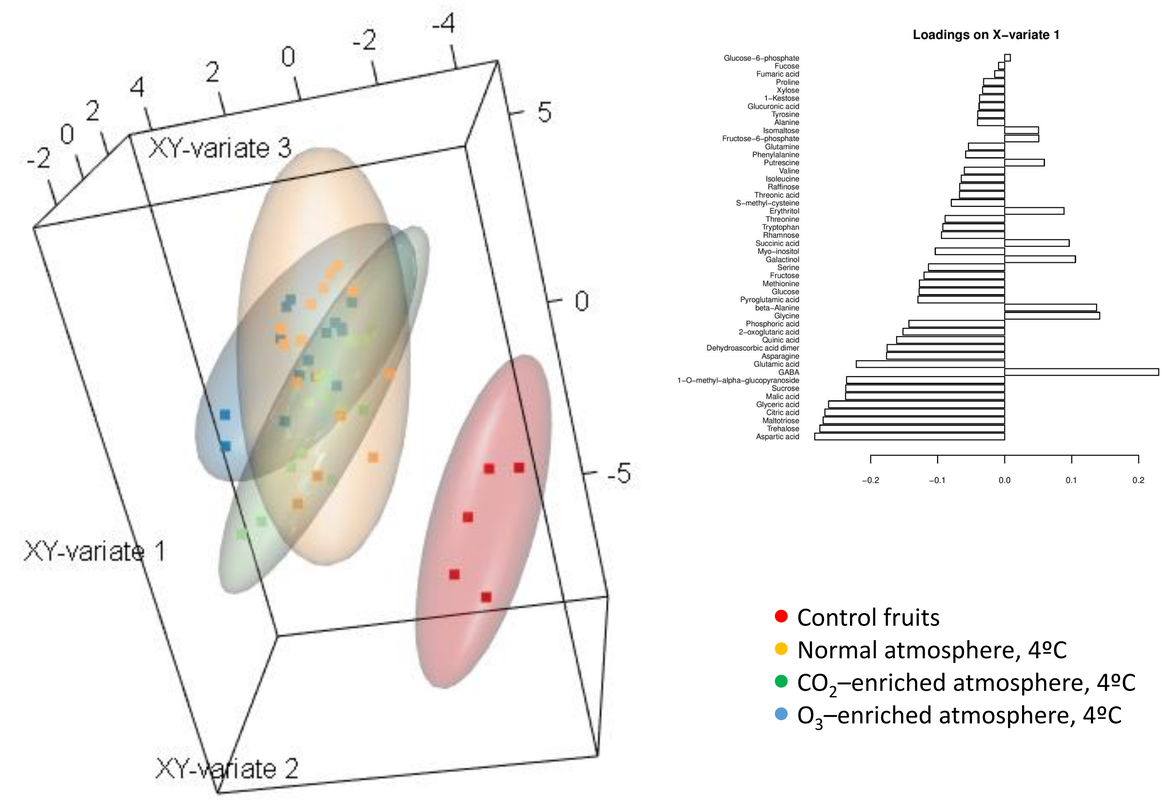

Figure 2: 3D partial least squares discriminant analysis of the samples for primary metabolites. Control fruits sampes are separated from the three postharvest treatment by components 1 (34% of explained variance) and 3 (11%). Loading scores for component 1 are shown .

3. Four main clusters of secondary metabolites were obtained by hierarchical cluster analysis (HCA) of the postharvest samples and their controls.

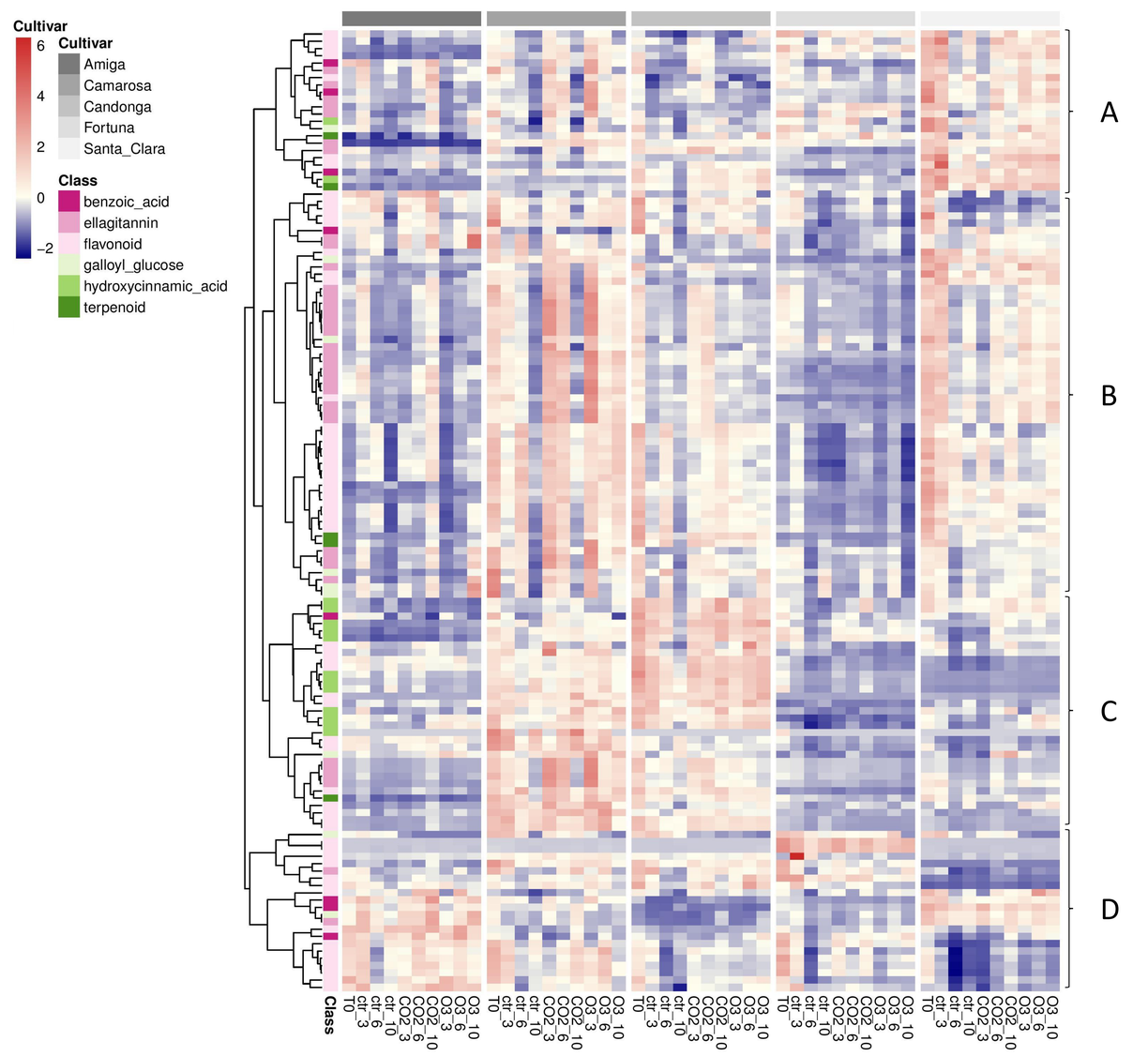

Figure 3: HCA for secondary metabolites. Metabolites are grouped by Pearson correlation, while samples are ordered by cultivars and treatments (T0: control fruits, ctr: normal atmosphere, CO2: CO_2-enriched atmosphere, O3: O_3-enriched atmosphere. 3, 6 and 10 indicate the duration of the postharvest treatments). Cluster A is enriched in ellagitannins (lagerstannins) and flavonols, cluster B in ellagitannins (soluble tannins) and proanthocyanidins (condensed tannins), cluster C in hydroxycinnamic acid derivatives and flavonoids and cluster D in flavonoids (anthocyanins and flavonones).

4. Log2 fold change of volatiles in the postharvest samples showed some drastic changes, attenuated initially by ozone treatment.

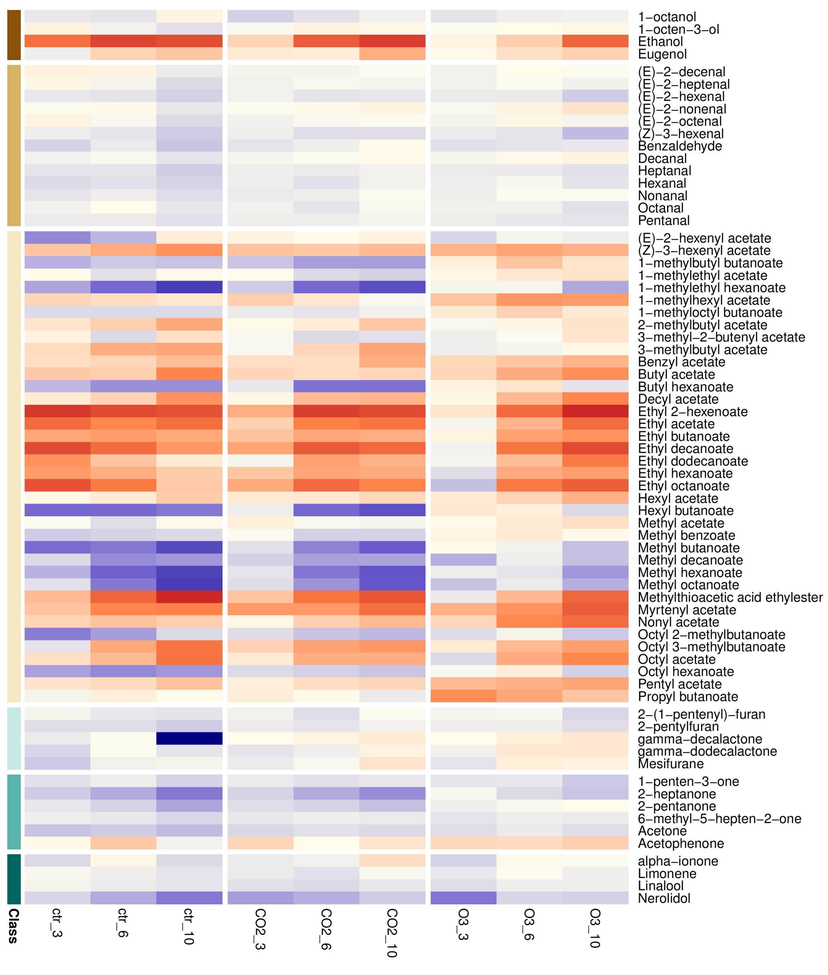

Figure 4: Log2 fold change in 'Candonga' cultivar postharvest samples for volatile content (ctr: normal atmosphere, CO2: CO_2-enriched atmosphere, O3: O_3-enriched atmosphere. 3, 6 and 10 indicate the duration of the postharvest treatments).

CONCLUSIONS

- Multivariate statistical approaches pointed some common trends in postharvest samples when compared to control fruits, while other patterns were cultivar- or treatment-specific.
- Volatile profiles are more dramatically affected by postharvest than primary or secondary metabolites, even if ozone-enriched atmosphere was able to delay these alterations (Figure 4)
- Some primary metabolites, which could be related with postharvest samples, have been associated with abiotic stress (Figure 2; Rohloff et al., 2012; Palma et al., 2014).

AKNOWLEDGMENTS

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