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Lipid oxidation and co-oxidation reactions in oleosome dispersions from various sources: Which constituents are involved?

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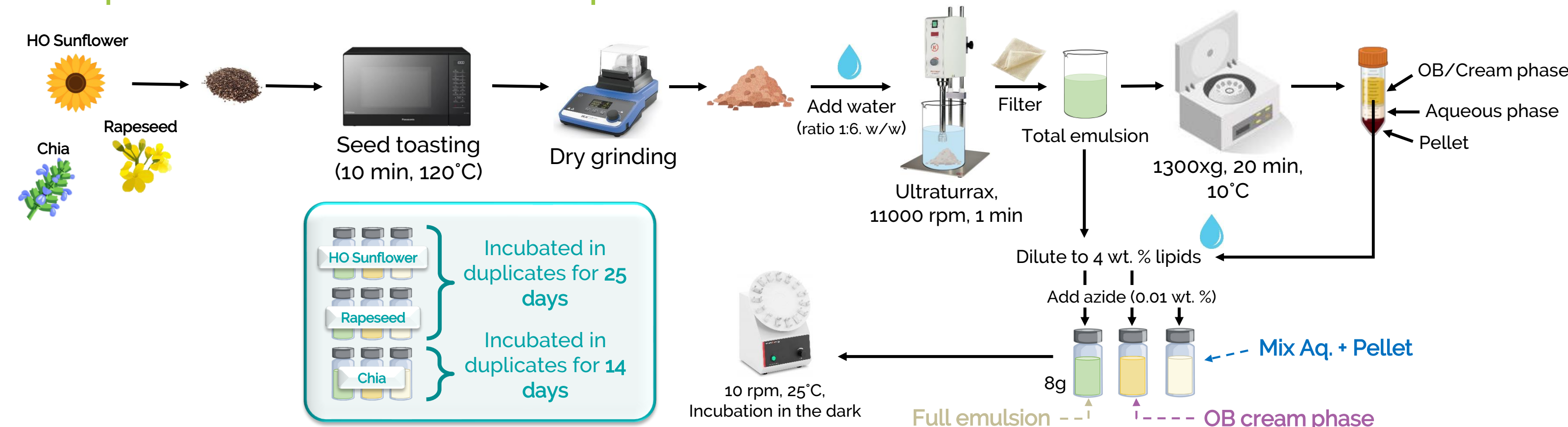
INTRODUCTION AND CONTEXT

In a context of shifting human diets towards alternatives with increased sustainability and nutritional quality, a strong interest has emerged in promoting the use of plant-based and minimally processed food ingredients and products. Amongst the many options that are currently in the spotlight, **oilseeds** have raised strong interest, as they are rich in **polyunsaturated fatty acids (PUFAs)** and other valuable components (**proteins, antioxidants**, etc.).

To make the extraction of lipids from these oilseeds **more environmentally friendly**, we studied lipids in the form of **oil bodies (OB)**, also known as **oleosomes**. Given their high PUFA content, assessing their **oxidative stability** is a logical step when targeting **food applications**. **OB dispersions** from **high oleic sunflower** seeds, **rapeseeds** or **chia** seeds were prepared and **incubated** under selected conditions to monitor their **physical** and **oxidative stability** over time.

EXPERIMENTAL APPROACH

1. Preparation of oleosome dispersions and incubation

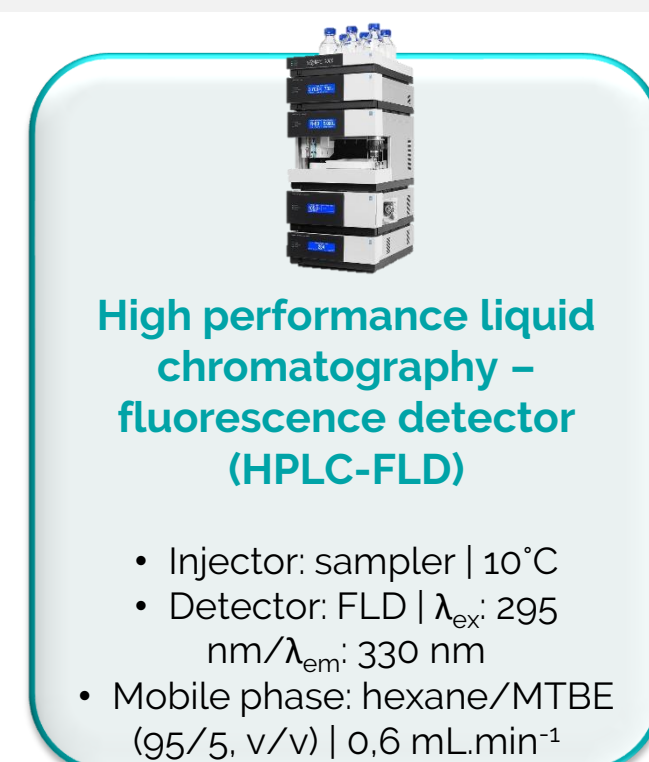


2. Analytic methods

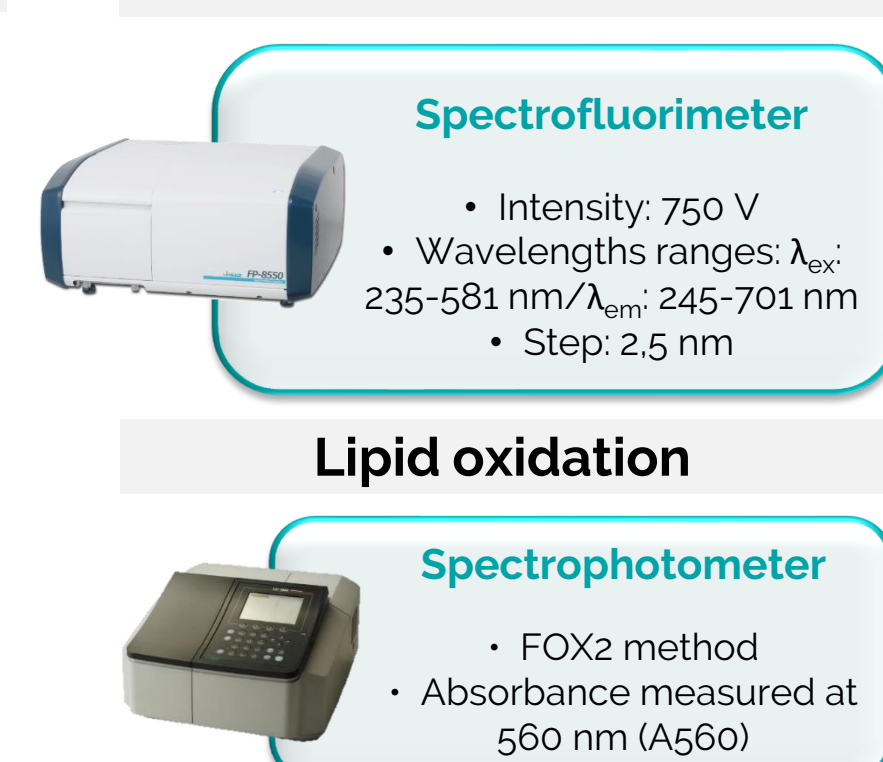
Oxygen consumption



Antioxidants



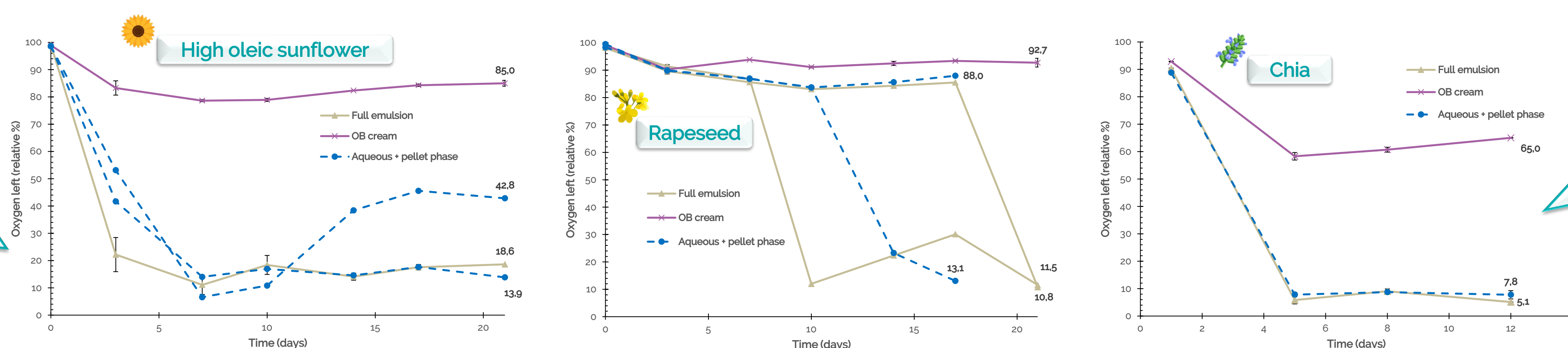
Protein oxidation



RESULTS

1. Oxygen consumption

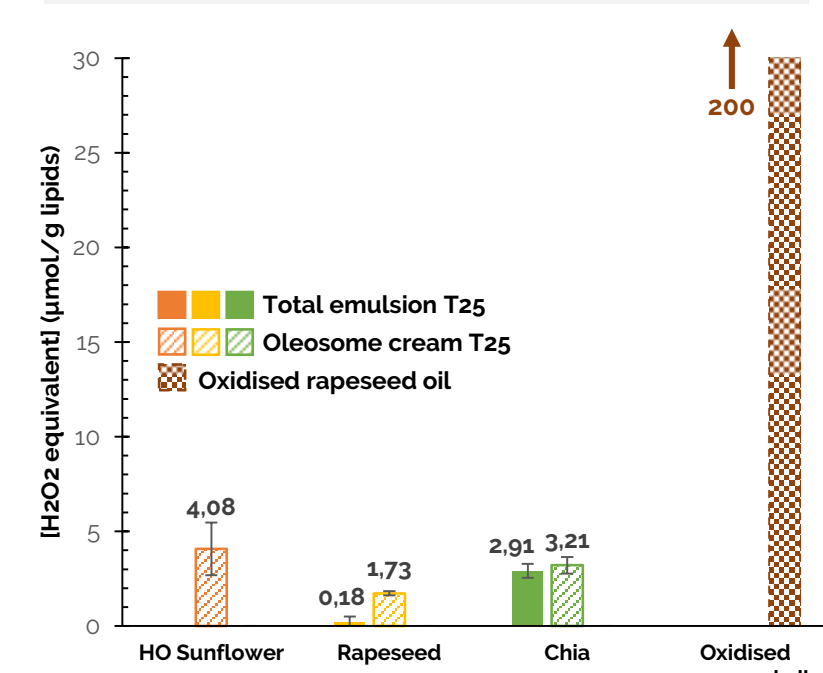
Upon incubation, we measured the **consumption of O₂** in the **tubes' headspace** for the different systems. Washed OB suspensions hardly showed O₂ consumption, except for the **chia OB** after **day 5**.



Conversely, in the tubes containing the full suspensions and the **Aq+Pellet mix**, extensive O₂ consumption occurred rapidly, showing that these systems are prone to oxidation. Which **constituents** of these systems are **responsible or targeted**?

2. Lipid oxidation?

Hydroperoxide content

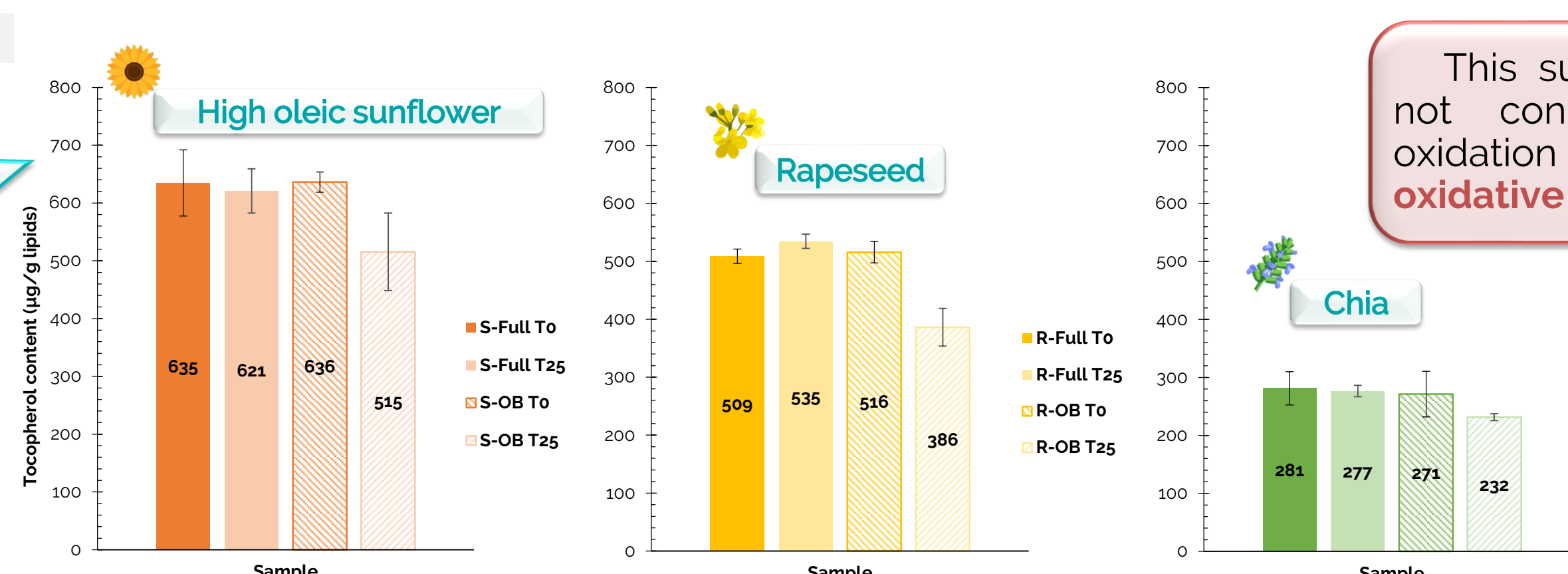


When measuring lipid oxidation markers such as **hydroperoxides** in these full suspensions, low levels were found (**<10 μmol of H₂O₂ equivalent/g lipids**).

Looking at **conjugated dienes** and **thiobarbituric acid reactive substances (TBARS)** absorbance's profiles. We weren't able to find their typical fingerprint. This is mainly due to the **complex composition** of the studied matrices and the **very low level of the markers**.

Tocopherol content

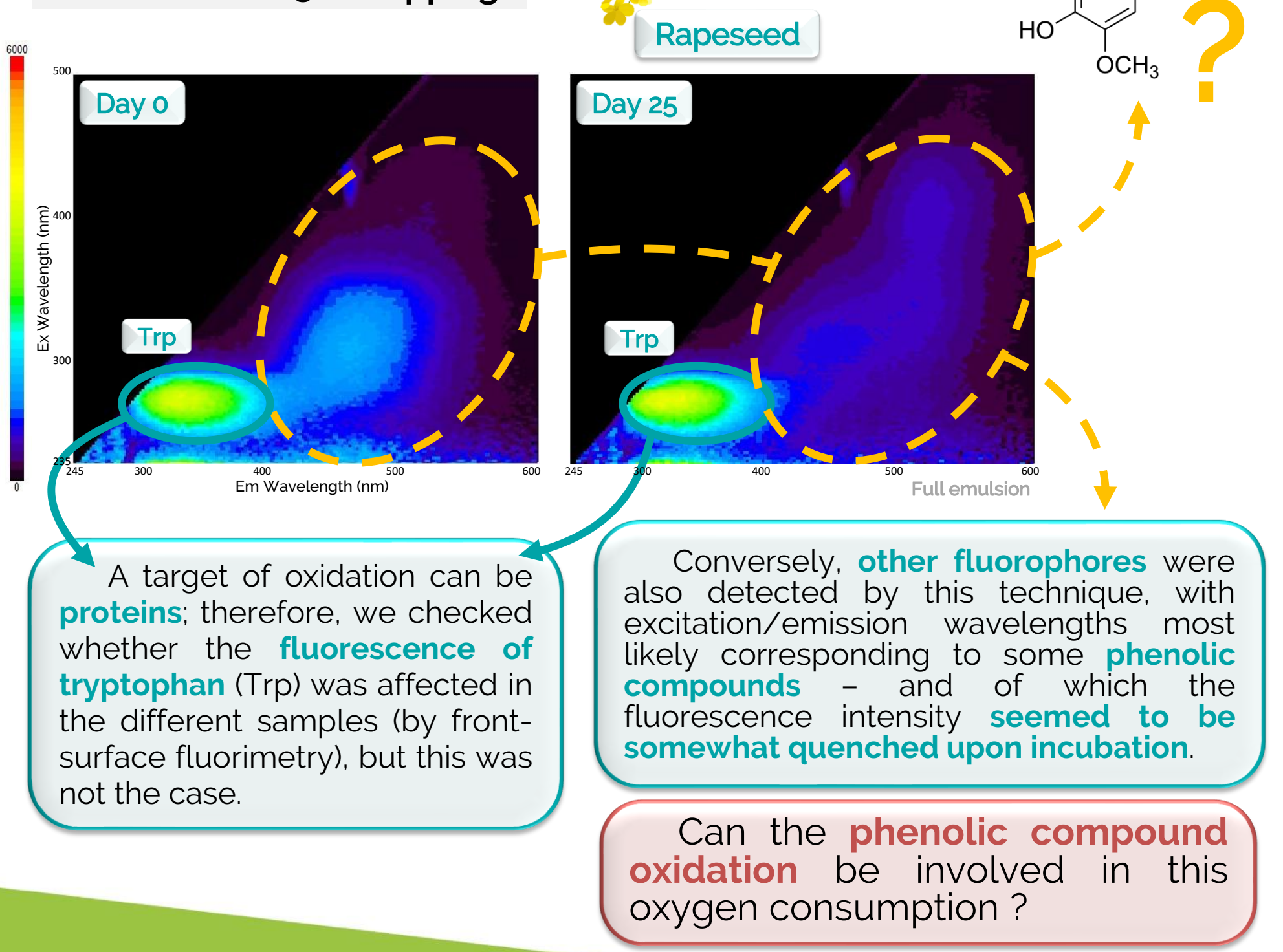
Tocopherol content remains almost constant (except a **slight decrease** in **all OB phases**) upon storage at 25°C, whatever their initial level (seed dependent).



This suggests that O₂ is not consumed by lipid oxidation but by **other oxidative reactions**.

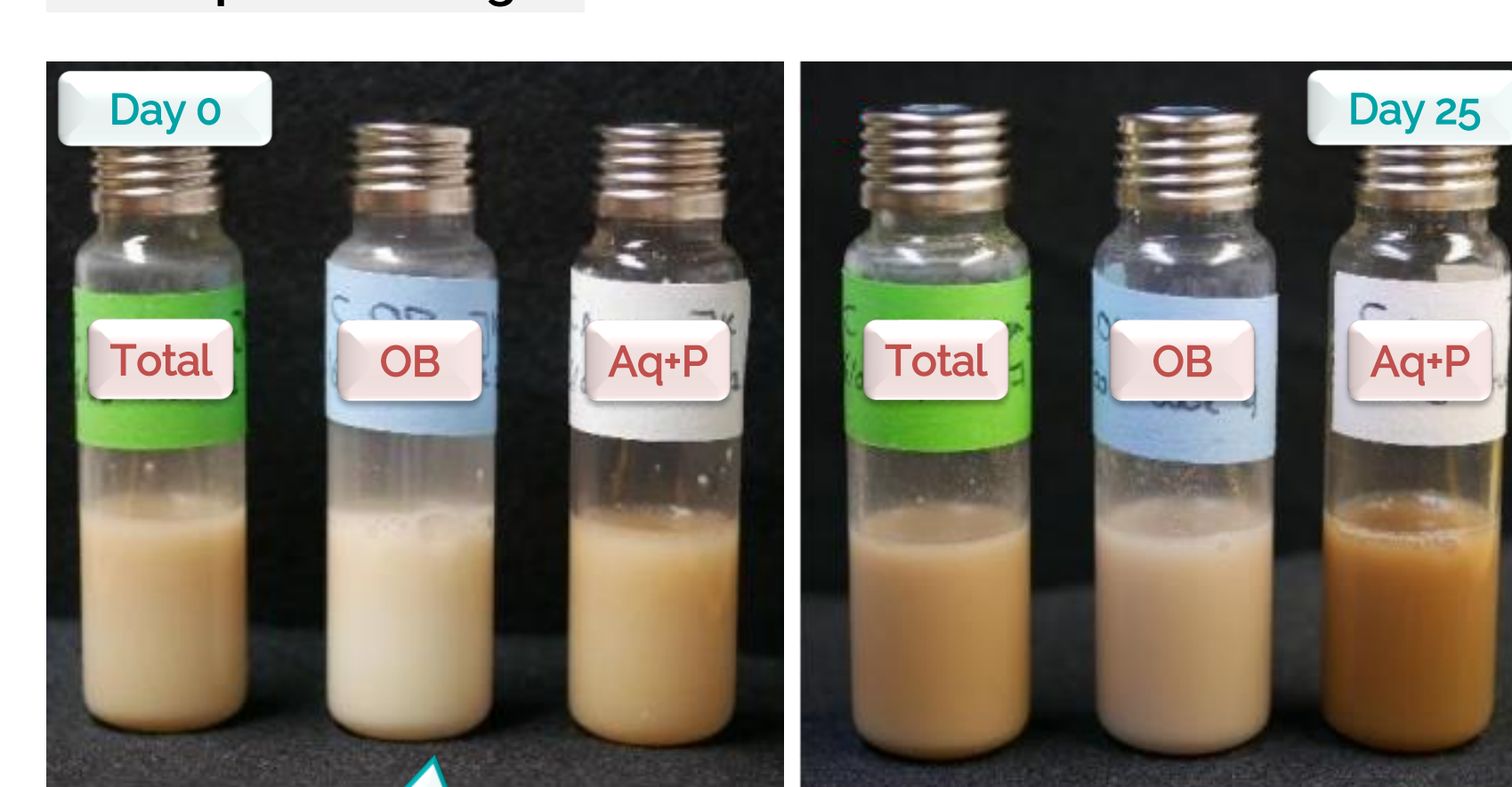
3. Protein oxidation?

Fluorescence 3D-mapping



4. Phenolic compound oxidation?

Sample browning



Considering the hypothesis of phenolic compounds' oxidation, we referred to the **browning phenomenon** that occurred in tubes. This may indicate that phenolic compounds, present in the full suspensions and in the Aq+Pellet mix but largely eliminated in the OB suspensions, **substantially oxidize**.

To confirm this hypothesis, some headspace tubes were opened during incubation so that oxygen **was no longer a limiting factor in the oxidation reaction**. It was found that oxygen **kept being consumed** as more was added to the tubes and that **browning increased sharply in the opened samples**.



O₂ consumption and **browning phenomenon** seem to be **correlated**.

CONCLUSIONS AND PROSPECTS

- These results confirm that OB overall exhibit a good resistance to lipid oxidation, as often claimed in literature. Yet, it reveals that other oxidative reactions may be at play in such systems, involving the non-OB constituents of the oilseeds.
- Further investigations of the exact substrates and reactions involved are ongoing, and will be important outcomes to rationalize the extent of purification that is needed to yield stable OB systems for applications.