

# Evaluating the effectiveness of a natural extract rich in $\alpha$ -tocopherol under frying conditions

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## INTRODUCTION

During frying process, oil degradation occurs leading to the generation of a wide variety of potentially toxic compounds (1), which can migrate to the food and consequently be absorbed through the diet. Due to this, there is an urgent need of finding strategies able to retard frying oil degradation and thus improve the quality and safety of fried food. Among these, the addition of antioxidant compounds is a well-known strategy. As consumers claim for clean labeling and sustainable foods, the interest is currently being focused on compounds of natural origin that could be effective at such severe conditions. However, so far, few studies investigating the performance of natural antioxidants at frying temperatures are available particularly regarding tocopherols and their mixtures. Moreover, certain discrepancies on the effectiveness of these compounds can be found in literature (2,3), which can be due to the methodologies employed for evaluating frying oil stability. In this sense, other techniques allowing a wider picture of oil thermodegradation process may help to shed light on this issue.

## MATERIALS AND METHODS

**SAMPLES:** Refined sunflower oil (SF) and a natural tocopherol extract rich in  $\alpha$  isoform (33 %  $\alpha$ , 10 %  $\beta$ + $\gamma$ , 7%  $\delta$  isoforms and 50 % sunflower oil) were acquired. SF was enriched with the extract at 0.02% (SF+0.02), 0.1% (SF+0.1) and 0.5% (SU+0.5).

**HEATING EXPERIMENTS IN THE ABSENCE OF FOOD:** Oil samples (3 liters) were heated in fryers set at 170 °C for periods of 6 h/day until the 25 % of polar compounds (legal threshold for frying oil reuse) was reached.

**STUDY OF THE SAMPLES:** Oil samples were periodically analyzed by several techniques: Proton Nuclear Magnetic Resonance ( $^1\text{H NMR}$ ), Direct Immersion-Solid Phase Microextraction followed by Gas Chromatography-Mass Spectrometry (DI-SPME-GC/MS), Testo 270 instrument and Visco Star Plus+L Viscosimeter.

## OBJECTIVE

To study the effect of adding up to 0.5 % (w/w) natural tocopherol extract rich in  $\alpha$  isoform on sunflower oil stability under frying conditions, paying particular attention to the generation of products arising from the degradation of both linoleate and tocopherols themselves

## RESULTS AND DISCUSSION

### Evolution of linoleate content throughout the heating time

The enrichment of sunflower oil with the natural extract rich in  $\alpha$ -tocopherol at any of the assayed concentrations had no effect on the oil thermodegradation, being almost the same the rate of linoleate degradation in the 4 types of oils (see Fig.1).

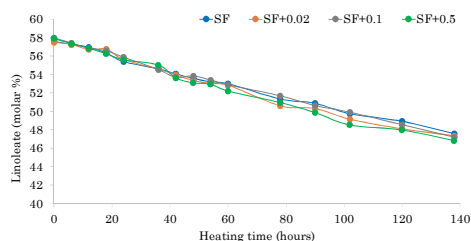


Fig.1. Evolution of the molar % of linoleate in sunflower oil, either enriched (SF+0.02, SF+0.1, SF+0.5) or not (SF), when heated at 170 °C.

### Generation of oxidation products

In line with that observed for linoleate degradation, similar profiles of oxidation products were detected among samples. As shown in Fig.2, these were mainly *E,E*-2,4-alkadienals (signal a), *E*-2-alkenals (signal b), alkanals (signal c), *Z,E* and *E,E*-keto-octadecadienoates (signal d and e), *Z,E*-2,4-alkadienals (signal f), oxo-alkanals (signal g). At the highest enrichment level, slightly lower concentrations of *E*-2-alkenals and alkanals were noticed.

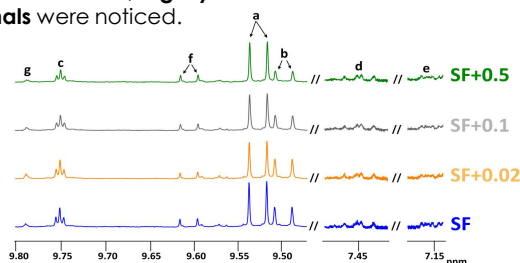


Fig.2. Enlargements of certain regions of the  $^1\text{H NMR}$  spectra of oil samples taken at the end of the experiment (138<sup>th</sup> hour)

### Changes in the viscosity of the frying oil

As a result of polymerization reactions, under frying conditions the oil viscosity gradually increased. From the 60<sup>th</sup> hour onwards, a higher increase was noticed in enriched oils than in the control, especially at the highest enrichment level. Thus, the tocopherol rich extract enhanced polymerization reactions at advanced heating times.

### Fate of tocopherols in SF with the highest enrichment level

As observed in Fig.3,  $\alpha$  isoform showed the highest degradation rate, followed by  $\gamma$ ,  $\delta$  and  $\beta$  isoforms. As a result, 7 tocopherol-derived compounds were detected by DI-SPME-GC/MS (see Fig.4). To the best of our knowledge, formyl derivatives have been detected for the first time as tocopherol degradation compounds in oils.

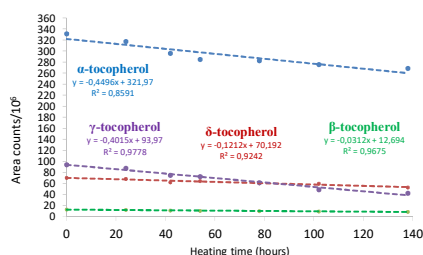


Fig.3. Evolution of abundances of tocopherols in SF+0.5 throughout the heating experiment by means of DI-SPME-GC/MS.

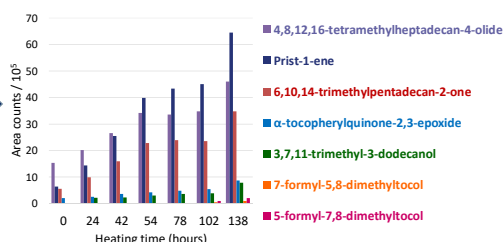
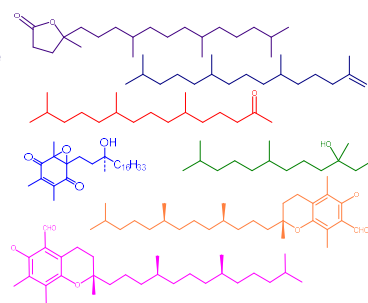


Fig.4. Evolution of abundances of tocopherol-derived products detected in SF+0.5 by means of DI-SPME-GC/MS.



## CONCLUSIONS

- The natural tocopherol extract tested did not increase sunflower oil stability at frying temperatures. At the highest enrichment level (0.5%) polymerization reactions seemed to be enhanced, whereas alkanals and *E*-2-alkenals were generated at slightly lower amounts.
- DI-SPME-GC/MS showed that  $\alpha$  isoform was degraded at the highest rate. Likewise, this technique allowed the detection of seven tocopherol-derived degradation compounds.

## REFERENCES

- Guillén & Uriarte (2012). Food Chem, 131(3): 915-926.
- Aladadunye & Przybylski (2012). J Am Oil Chem Soc, 89:41-53.

## ACKNOWLEDGEMENTS

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