Determination of global heat transfer coefficient in olive paste malaxation and its impact on olive oil quality outcome

INTERNATIONAL CONFERENCE ON SUSTAINABILITY IN OLIVE CULTIVATION (ICSOC 2025)

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BACKGROUND

Precise control of the olive paste mass loaded along with the time–temperature conditions during malaxation, is essential for producing olive oil with superior chemical and sensory properties. However, maintaining these conditions is challenging due to the low ratio of heat transfer surface area to olive paste volume and the paste's high viscosity. A deeper understanding of heat transfer kinetics enables more effective monitoring and control of processing conditions. To this end, the global heat transfer coefficient (U) was estimated under varying conditions (mass, time, temperature) and its values were correlated with several chemical and sensory attributes of extra virgin olive oil (EVOO).

MATERIALS & METHODS

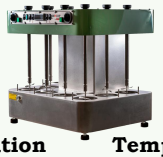
Plant extraction plant Abencor system (Comercial Abengoa S.A., Sevilla, Spain)

I Mill

350g olive paste

700g olive paste

II Malaxation



Duration	Temperature
30 min	25°C
45min	32°C
60min	45°C

III Centrifugation

IV. Chemical/sensory analysis of EVOO (cv. Cobrançosa)

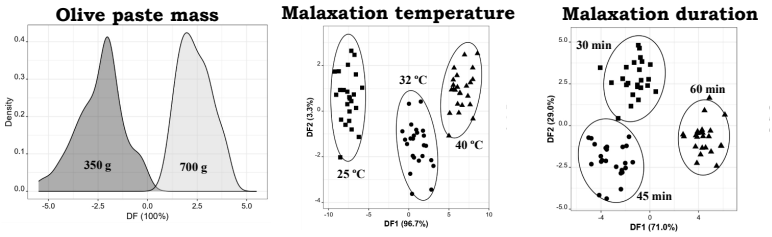
V. Global heat transfer coefficient (U) estimation

$$U = \frac{\dot{m}Cp(Te - Tb)}{A\Delta T}$$

m, flow mass; ***Cp***, olive past specific heat; ***Te***, olive paste temperature after malaxation; ***Tb***, olive paste temperature prior to malaxation; ***A***, heat transfer surface área.

RESULTS

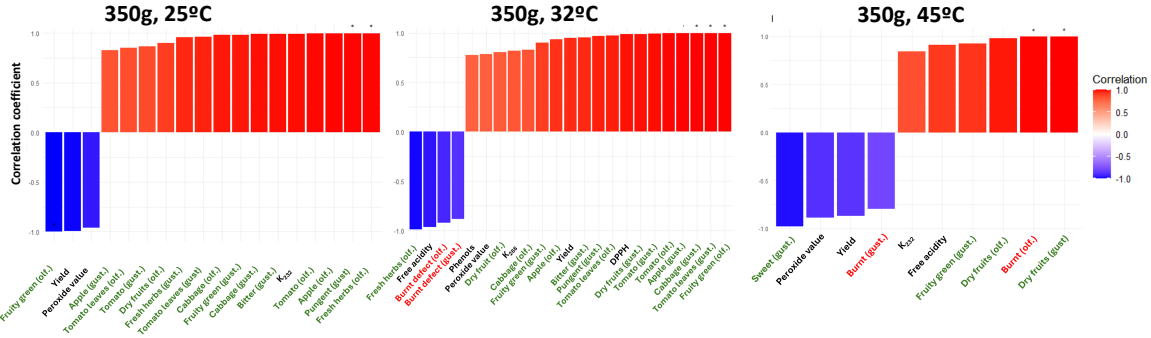
I. Linear discriminant analysis (LDA) for variables tested

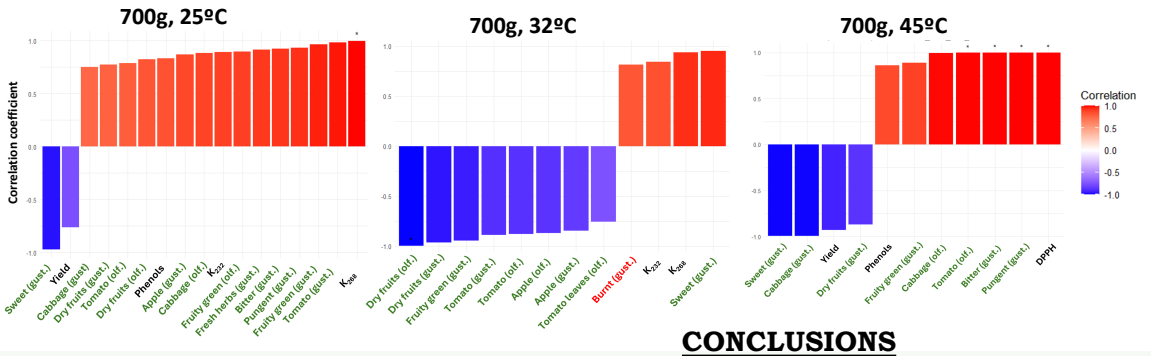


- LDA shows clear separation of samples according to:
  - paste mass
  - malaxation temperature, and
  - malaxation time
- Strong influence of processing variables on EVOO chemical-sensory profiles

II. Correlation analysis between U and chemical/sensory parameters across the different malaxation durations tested (30, 45 and 60 min)

(sensory parameters highlighted in green, defects in red, and physicochemical in black)





- **350 g paste**

U values at:

25–32°C → correlated positively with fresh fruity and green attributes

45°C → correlated negatively with burnt gustatory defect and positively with burnt olfactory defect and dry-fruit attributes

- **700 g paste**

U values at:

25°C → correlated positively with most of sensory positive attributes

32°C → correlated negatively with most of sensory positive attributes, emerging burnt and oxidation markers as the main positive drivers

45°C → correlated positively with sensory positive attributes and antioxidant activity, suggesting recovery of sensory complexity

CONCLUSIONS

U → is a key variable linking malaxation conditions to both sensory and chemical properties EVOO.

U → impacts EVOO chemical-sensory profiles allowing identifying the best malaxation time and temperature.

U → is a process parameter that contribute to better understand and optimize olive oil quality.

Acknowledgments: This work was supported by Recovery and Resilience Plan (PRR) within the project "Sustain Olive- Organic Olive Oil: implementation of innovative strategies for sustainable production, recovery and consumption" (PRR-C05-i03-I-000187-LA9.5), as well as the Mountain Research Center – CIMO, UIDB/00690/2020 (DOI:10.54499/UIDB/00690/2020) and UIDP/00690/2020 (DOI:10.54499/UIDP/00690/2020) and SusTEC, LA/P/0007/2020 (DOI:10.54499/LA/P/0007/2020). Davide Martins acknowledges national funding provided by PRR (PRR Aviso nº 15/C05-i03/2021) for his contract within the project "SustainOlive- Organic Olive Oil: implementation of innovative strategies for sustainable production, recovery and consumption" (PRR-C05-i03-I-000187-LA9.5)