Thermal Treatment of Oil Bodies to Improve Physical and Chemical Stability

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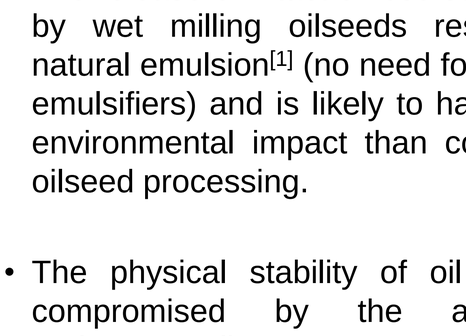
Introduction

- The release of intact oil bodies (Figure 1) by wet milling oilseeds results in a natural emulsion[1] (no need for additional emulsifiers) and is likely to have a lower environmental impact than conventional oilseed processing.
- The physical stability of oil bodies is compromised by the activity of endogenous lipase enzymes carried over in the extract.

AIM

- Measure the correlation between lipase activity in oil bodies and the impact of thermal treatment on their physical and chemical/oxidative stability over storage.



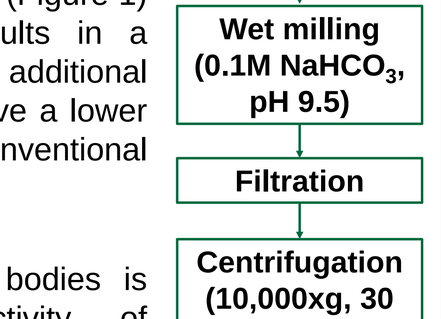


Figure 1: Recovery of oil bodies by wet milling

Oilseeds
↓
Soaking (16 h, 4 °C)
↓
Wet milling (0.1M $NaHCO_3$, pH 9.5)
↓
Filtration
↓
Centrifugation (10,000xg, 30 min.)
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Collection of the crude cream
↓
Removal of exogenous material
↓
Thermal stabilization (95 °C, 0 to 6 min.)

Effect of recovery media and thermal treatment on lipase activity

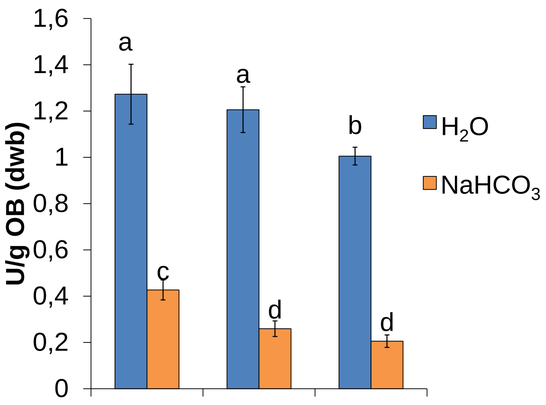


Figure 2: Carry over of enzymes as affected by recovery solution

- dH_2O or 0.1M $NaHCO_3$ solutions were used to recover oil bodies
- Lipase activity was significantly reduced in oil bodies recovered using the $NaHCO_3$ solution

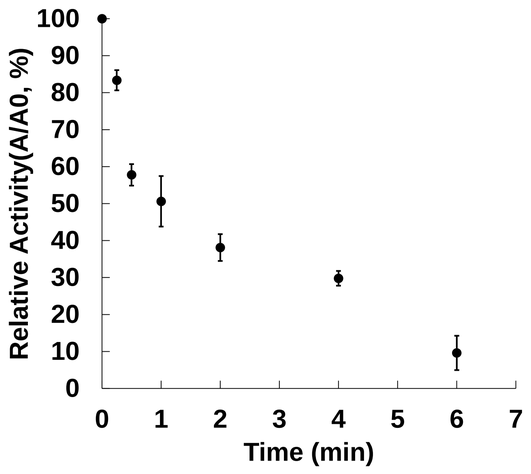


Figure 3: Inactivation of lipase at 95 °C

- Thermal treatment reduced lipase activity by 90% over the first 6 minutes.
- Thermal process could be shortened considerably compared with the one suggested in literature[2].

Influence of thermal treatment on emulsion properties over storage

- ζ-potential is a measurement of the surface charge and hydrodynamic mobility of a colloidal system, affected by the presence of charged components at the interface (e.g. oleosin and phospholipids)
- Rapeseed oil bodies extracted in $NaHCO_3$ 0.1 M, thermally treated (6 minutes, 95 °C) were stored at 20 °C for 1 month.

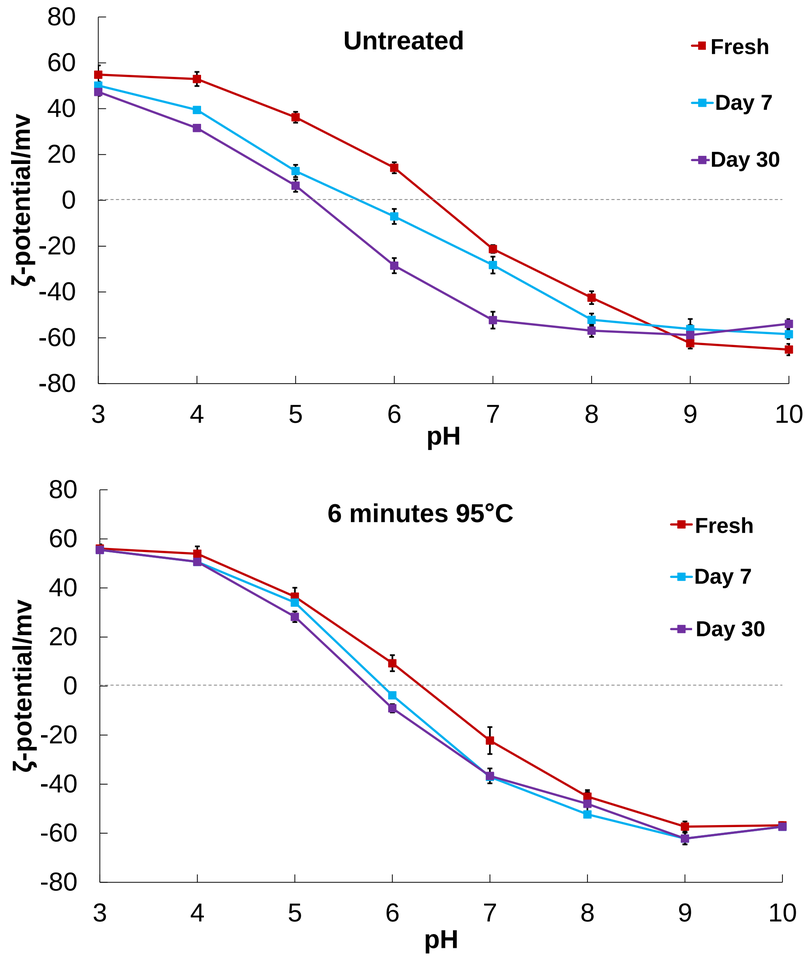


Figure 4: effect of thermal treatement on the zeta-potential of aged emulsions

- Any change in surface charge may be related to enzyme activity affecting surface protein or lipid constituents
- Thermally treated emulsions, with lower lipase activity, show less of a change in surface charge over time than untreated samples

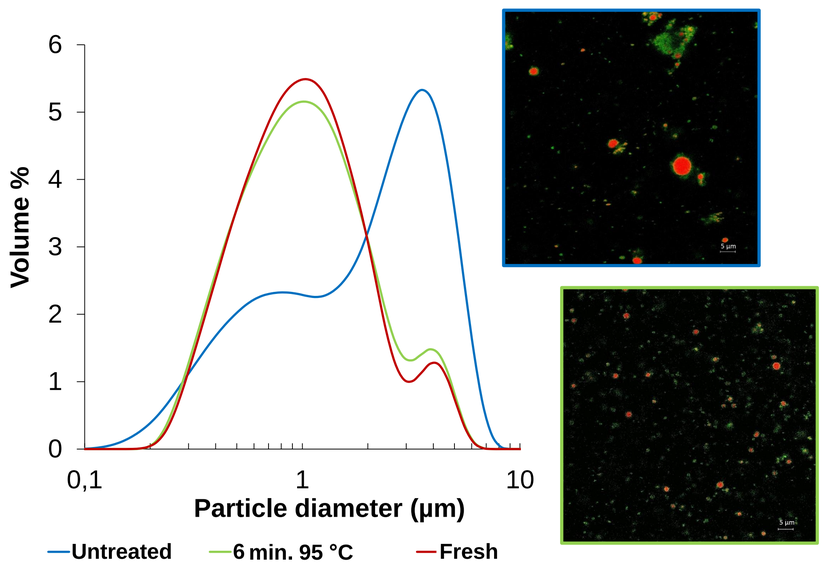
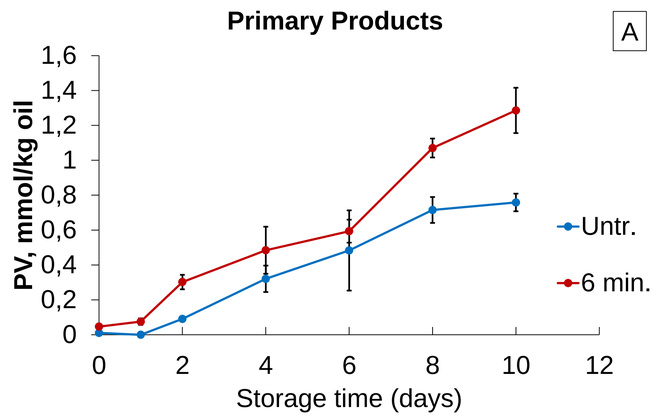


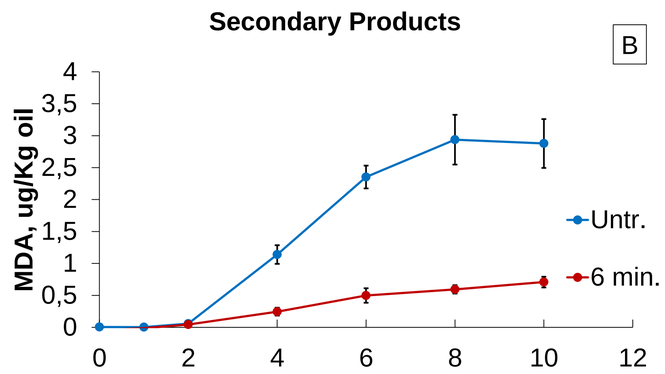
Figure 5: Particle size and confocal images of fresh and aged emulsions

- Particle size analysis was performed on aged emulsions stored at 20 °C for 2 months (+ 0.05% NaN_3 used as a preservative).
- The thermal treatment, corresponding to a 90% reduction of lipase activity, has significantly improved the stability of the emulsion.

Influence of thermal treatment on oxidative stability

- Oxidative stability was assessed measuring primary and secondary products over accelerated storage at 40 °C.
- Natural antioxidants (intrinsic components in oil bodies) were measured over storage.





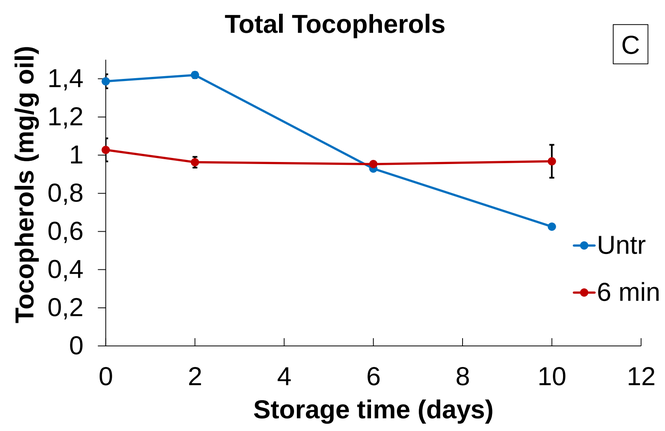


Figure 6: Oxidative stability of oil body emulsions (A and B). Tocopherol concentration over storage (C)

- Thermal treatment significantly improved the oxidative stability of oil body emulsions.
- Tocopherol concentration decreased over storage of untreated samples.

Conclusions

- Heating oilseed rape oil bodies for 6 minutes at 95 °C creates a physically stable emulsion
- A significant reduction in the activity of enzymes (carried over during oil body recovery), that can affect the charge of surface components, probably explains this effect
- This thermal treatment also improves the oxidative stability of the oil body emulsion
- A reliable method for monitoring the effectiveness of oil body recovery and thermal treatment has been developed using a spectrophotometric assay for lipase activity.

References:

[1]: NIKIFORIDIS, C. V. & KIOSSEOGLOU, V. 2009. Aqueous extraction of oil bodies from maize germ (Zea mays) and characterization of the resulting natural oil-in-water emulsion. *J Agric Food Chem,* 57**,** 5591-6.
[2]:CHEN, B. C., MCCLEMENTS, D. J., GRAY, D. A. & DECKER, E. A. 2012. Physical and oxidative stability of pre-emulsified oil bodies extracted from soybeans. *Food Chemistry,* 132**,** 1514-1520.

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