Oil bodies as a source of naturally pre-emulsified oil: novel methodologies for extraction and stabilization.

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Introduction

Oil bodies are sub-cellular droplets representing the main form of energy storage in oleaginous plant seeds[1]. The current manufacturing process of oil extraction and refining requires organic solvents and a significant energy input. The release of intact oil bodies by wet milling oilseeds (Figure 1) results in a natural emulsion[2] (no need for additional emulsifiers) and is likely to have a lower environmental impact than conventional oilseed processing. The physical stability of oil bodies can be compromised by the action of enzymes carried over in the oil body preparation.

The literature does not provide precise parameters for thermal stabilization, and long holding times (up to 30 minutes) at high temperatures are usually implied in the process[3]. This is not ideal for the food industry and a deeper understanding of destabilization processes are needed. For this reason, a lipase assay has been developed to monitor the residual activity post thermal treatment, as indicator of effectiveness of the process (Figure 2).

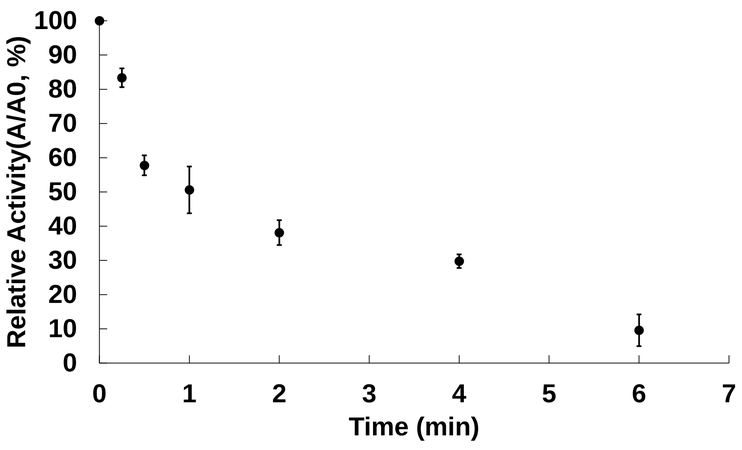
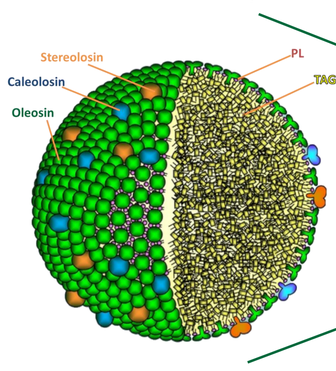


Figure 2: Inactivation of lipase at 95 °C



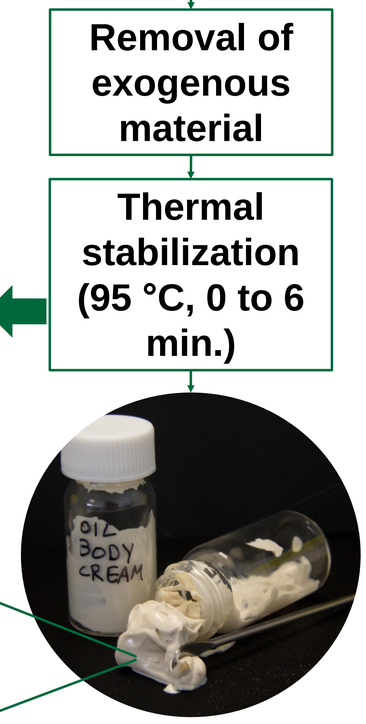
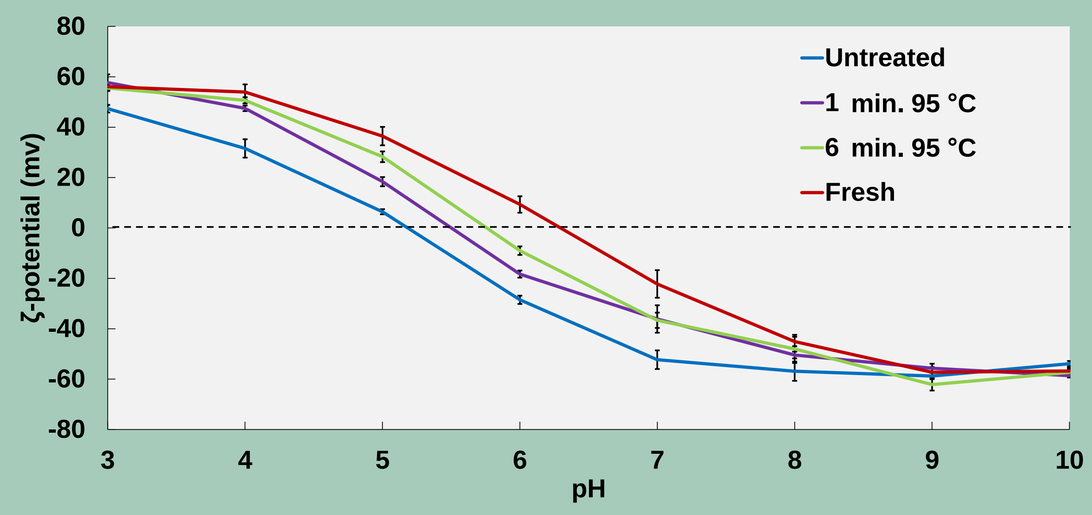


Figure 1: Extraction of oil bodies by wet milling

Surface charge characterization of aged oil body

ζ-potential is a measurement of the surface charge and hydrodynamic mobility of a colloidal system. Rapeseed oil bodies extracted in $NaHCO_3$ 0.1 M ,thermally treated (1 and 6 minutes, 95 °C) were stored at 20 °C for 3 weeks.
Oil body emulsions were adjusted to pH values from 3 to 10 and the ζ-potential was measured.



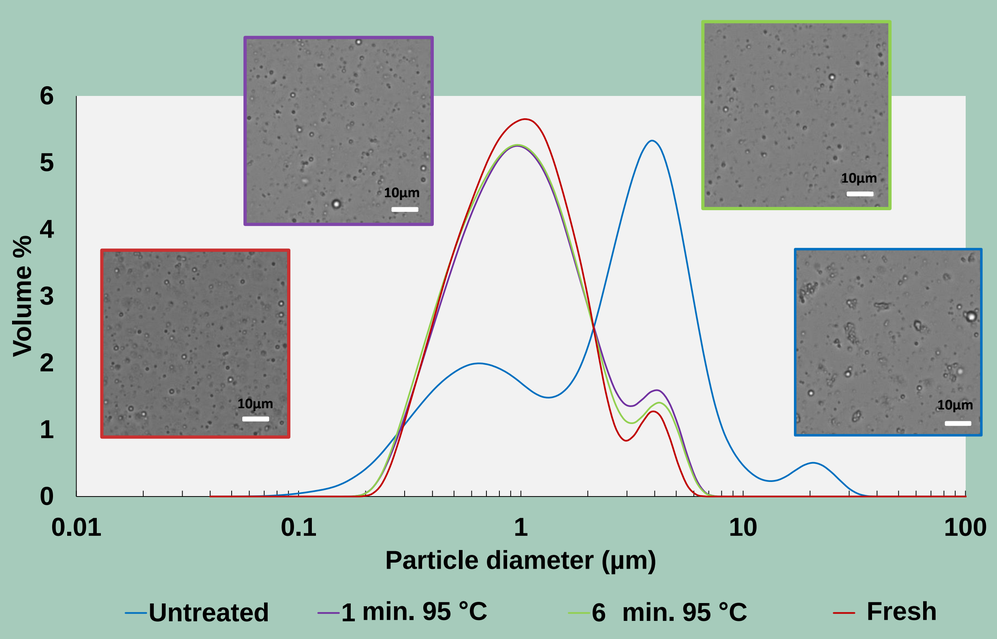
The surface charge of all the oil body preparations show a dependency on pH value. The ζ-potential of untreated emulsions shifted towards more negative values for the altered composition of the droplet surface. The results suggest that oleosin may have changed conformation on the surface, as an effect of the presence of free fatty acids produced by lipase activity on triacylglycerol molecules. Moreover, the change in conformation might not allow a sufficient coverage of the droplet surface, promoting coalescence.

Both thermally treated emulsions showed much limited changes of the charged components at the surface. Despite the denaturation of the most enzymatic activity, the 6 minutes thermally treated sample showed a decay of ζ-potential at pH 5 and 6. Those changes are more likely to be due to coalescence rather than residual enzymatic activity.

Conclusions

- **A method for the extraction of intact oil bodies has been developed using 0.1M $NaHCO_3$.**
- **A reliable method for monitoring the effectiveness of thermal treatment has been developed using a spectrophotometric assay for lipase activity.**
- **The length of thermal treatments of oil body emulsions could be remarkably shorter than the one suggested by literature.**
- **A thermal treatment of 1 and 6 minutes at 95 °C produced emulsions with similar properties during aging.**

Particle size thermally treated aged oil body



Particle size analysis and microscopy was performed on aged emulsions stored at 20 °C for 3 weeks with NaN_3 to avoid microbial spoilage. Fresh emulsion is shown as reference as the particle size distribution at the start of the storage trial. The length of thermal treatment was chosen based on the reduction by 50 and 90 % of the initial activity of lipase.

A loss of droplet structure and extended aggregates has been registered in the untreated sample, due to the high enzymatic activity. The thermal treatment has significantlty improved the stability of the emulsion. However, a limited coalescence occurs.

Future work

- **Confocal microscopy for a deeper understanding of aged oil body droplet structure**
- **Recovery of high valuable protein isolates from the extraction process.**
- **Development of a low-fat vegan mayonnaise based on oil body preparation**

References:

[1]: TZEN, J. T. C., CAO, Y. Z., LAURENT, P., RATNAYAKE, C. & HUANG, A. H. C. 1993. Lipids, Proteins, and Structure of Seed Oil Bodies from Diverse Species. *Plant Physiology,* 101**,** 267-276.
[2]: 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.
[3]: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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