# FAT-BASED ENCAPSULATION: PHYSICOCHEMICAL CHARACTERISATION AND RELEASE KINETICS

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Keywords:
- encapsulation
- cold extrusion
- physicochemical properties
- release kinetics

## 1. Introduction

Fat-based cold extrusion represents a high potential but largely unexplored encapsulation technique [1,2]. Understanding the functioning and efficiency of encapsulated systems the determination of physicochemical characteristics of materials and their interactions is crucial [3].

**Approach/Aim**

- matrix design of fat mixtures consisting of high-melting hydrogenated rapeseed oil + variable types and contents of low-melting fats/oil for encapsulation of 10% beetroot powder (RBP) by cold extrusion
- physicochemical characterization of fat matrices and encapsulants
- in-vitro release kinetics of encapsulated RBP

## 2. Methods

**Cold extrusion**

1) Fat Matrices: high-melting hydrogenated rapeseed oil (HMF) + 3% to 16% of low-melting fats (LMF): rapeseed oil (ROE)/palm kernal fat (PKF)/two coconut fats (COC; COP)
2) RBP encapsulants: matrix material = fat mixtures with 12% and 16% LMF; 10% encapsulated RBP

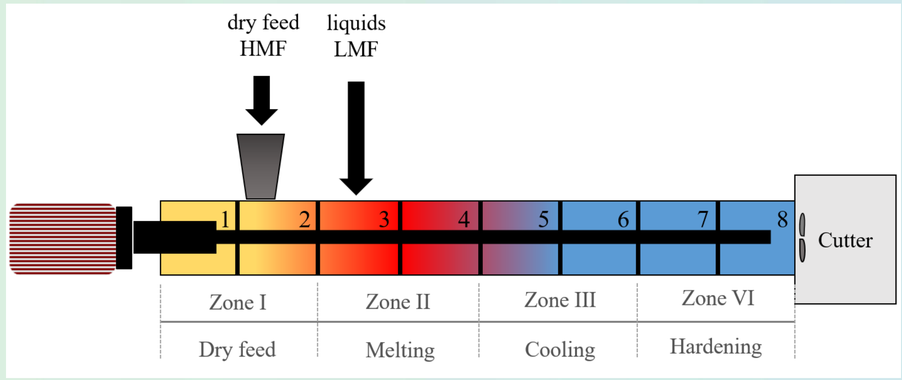


**Figure 1:** Schematic representation of encapsulation process by cold extrusion.

**Physicochemical Analyses**

- Particle size distribution (sieve analysis)
- Melting behaviour (DSC)
- Solid fat content (NMR)
- Microstructure (CLSM)

**Release kinetics of RBP encapsulants**

Encapsulation efficiency, release profile, release behaviour (UV-vis-spectrophotometry)

## 3. Results and Discussion

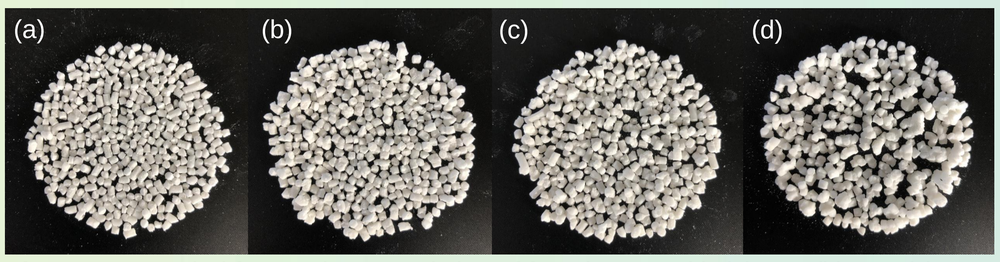


**Figure 3:** Extruded fat matrices consisting of fat mixtures with (a) 3%, (b) 6%, (c) 12% and (d) 16% ROE and HMF as a base.

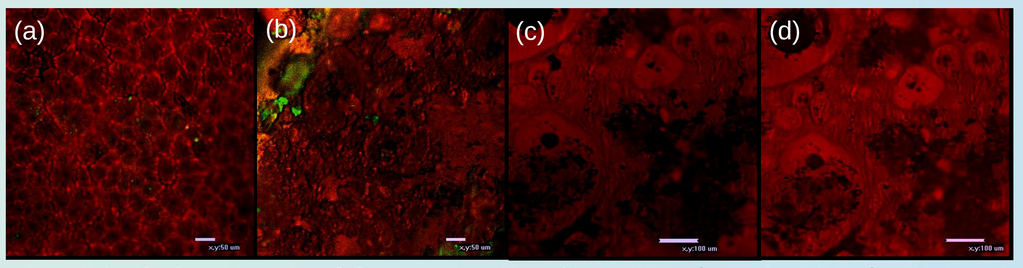


**Figure 6:** CLSM images of fat matrix with 16% PKF coloured with Nile Red and measured at (a) 25°C, (b) 37°C, (c) 37°C after 5h, (d) 37°C after 1d.

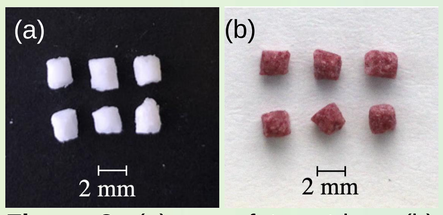


**Figure 2:** (a) pure fat matrices (b) and RBP encapsulants after extrusion and cutting.

Increasing share of LMF:

- increasing proportion of particles within size fraction > 2.8mm → agglomerates of a number of pellets
- softer consistency

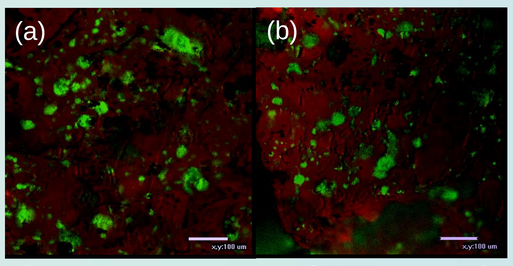


**Figure 7:** CLSM images of RBP encapsulants with 16% PKF in the matrix coloured with Nile Red and FITC measured at (a) 37°C after 5h, (b) 37°C after 1d.

- Influencing factors on melting behaviour: temperature and time
- increased storage duration led to increasing melt of fat crystals; homogeneouse RBP distribution

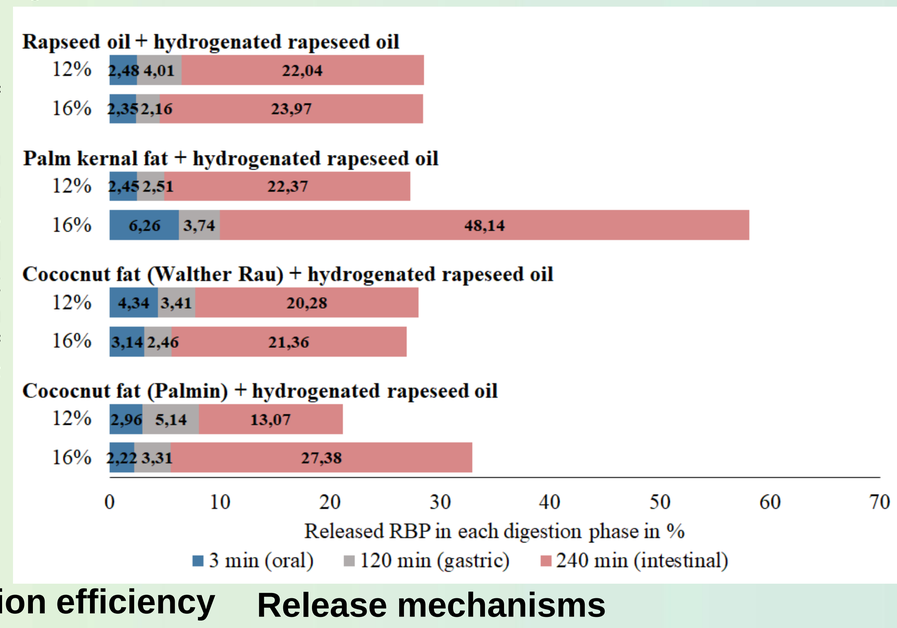


**Figure 5:** Total release of encapsulated RBP (10%) during digestion phases. The Matrix material consist of fat mixtures with 12% and 16% of LMF and HMF as a base.

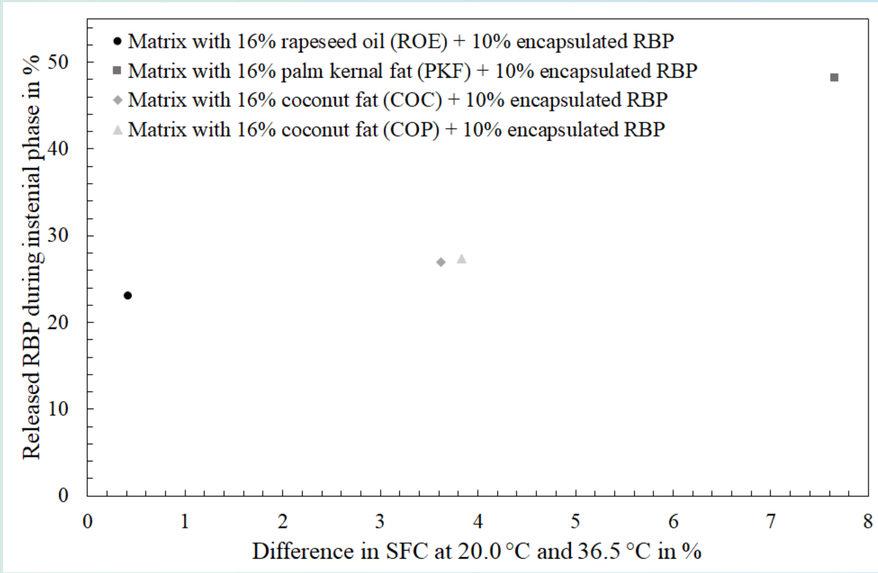


**Figure 8:** Comparison between deviations SFC at 20.0°C and 36.5°C and the released RBP during intestinal phase of fat matrices (10% encapsulated RBP). Matrix material: fat mixtures consisting of HMF as the base and 16% of LMF.

**Encapsulation efficiency**

- 12% LMF: ≈ 92.16%
- 16% LMF: ≈ 90.85%

**Release mechanisms**

- Melting (temperature & time dependent)
- Enzymatic lipid digestion

Correlation between released proportion of RBP during intesinal phase and deviation in SFC at 20.0°C and 36.5°C → 16% PKF in the matrix peformed best

## 4. Conclusion

- Good extrudability of fat mixtures up to a share of 16% LMF
- Matrix composition and encapsulated RBP impact physicochemical properties
- Thermal properties strongly influence release behaviour → deviations in solid fat content as a measure of structural changes in a temperature range of 20.0°C to 36.5°C are crucial

**References**

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