P74

Enhancing curcumin bioaccessibility through different nanoformulations

R. F. S. Gonçalves[1], J. T. Martins[1], C. M. Duarte[2], A. A. Vicente[1], A. C. Pinheiro[1,2,*]

[1]Centre of Biological Engineering, University of Minho, Braga, Portugal

[2]Instituto de Biologia Experimental e Tecnológica, Avenida da República, Quinta-do-Marquês, Estação Agronómica Nacional, Apartado 12, 2781-901 Oeiras, Portugal

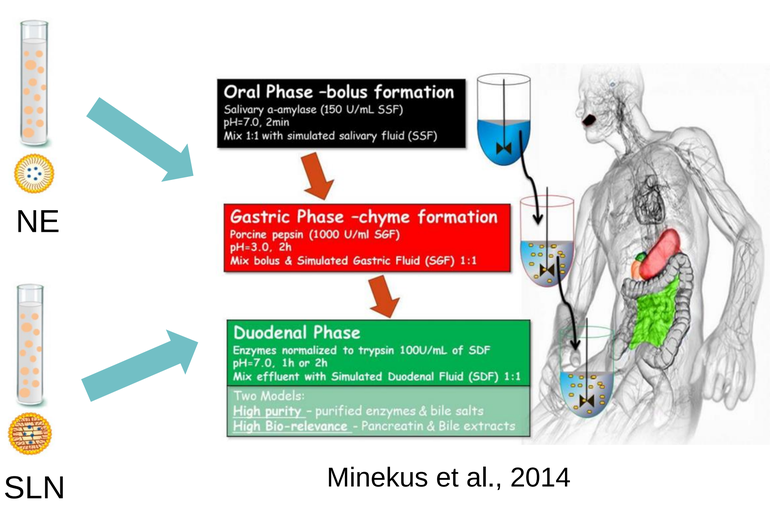
*anapinheiro@deb.uminho.pt

Introduction

Curcumin, a natural polyphenolic phytochemical, is known for its wide range of biological activities, however it has an extremely low water solubility as well as a low bioavailability, which limit its application as a bioactive ingredient in food. The use of delivery systems at nano-scale such as nanoemulsions (NE) and solid lipid nanoparticles (SLN) has been reported as a promising mean of improving the lipophilic bioactive compounds' bioavailability and their physical and chemical stability. However, the knowledge of the behaviour of different nanoformulations as well as the fate of bioactive compounds encapsulated within them in the gastrointestinal (GI) tract is of utmost importance to either assess their safety for human consumption and to produce tailored delivery systems (i.e. with optimized bioactivity). The aim of this work was the evaluation of the behaviour of two different bio-based nanoformulations (NE and SLN) incorporating curcumin when submitted to an *in vitro* digestion and the assessment of their cytotoxicity.

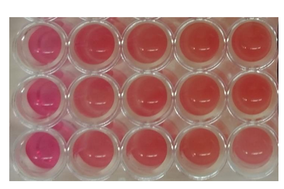
Methods

✓ *In vitro* digestion



Minekus et al., 2014

✓ Cytotoxicity



- MTT viability assay
  - Human colon carcinoma (Caco-2) cell line
  - NE and SLN with curcumin concentration ranging from 5 to 25 µg/ml
  - $Cell\ viability\ (\%) = \frac{A_{Experimental}}{A_{positive\ control}} x\ 100$

($A_{positive\ control}$: absorbance of medium incubated with cells; $A_{Experimental}$: absorbance of medium incubated with cells in contact with NE or SLN samples)

Results

✓ Size and zeta potential

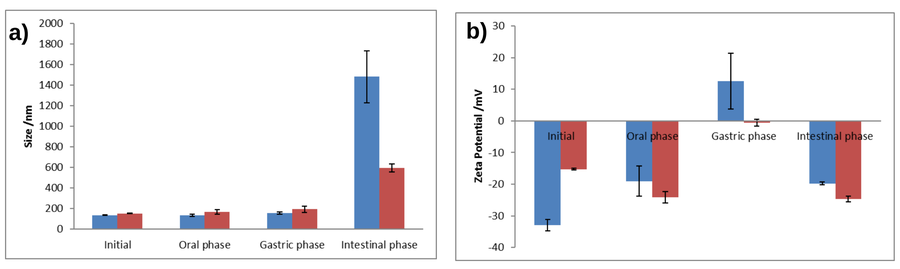


Figure 1 – Size (a) and zeta potential (b) of the curcumin NE (■) and SLN (■) as they undergo the different stages of *in vitro* digestion.

- Both nanoformulations are stable at oral and gastric conditions;
- NE are more unstable under intestinal conditions, exhibiting a larger increase in particle size (droplet coalescence);
- There are a pronounced differences in the interfacial composition of initial NE and SLN and throughout the *in vitro* digestion (i.e. gastric phase).

✓ FFA release

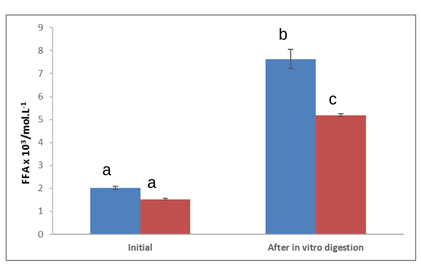


Figure 2 – FFA concentration of the curcumin NE (■) and SLN (■) before and after the *in vitro* digestion. [a-c]Different superscripts indicate significant differences among samples ($p < 0.05$).

- Higher amount of FFA released from NE;
- Physical state of the lipid droplets may have influenced the extent of hydrolysis.

✓ Bioaccessibility

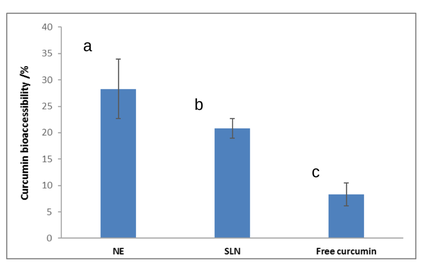


Figure 3 – Curcumin bioaccessibility after *in vitro* digestion in NE, SLN and free. [a-c]Different superscripts indicate significant differences among samples ($p < 0.05$).

- Curcumin bioaccessibility has been shown to increase 3.4 and 2.5 times when encapsulated in NE and SLN, respectively.

✓ Cytotoxiciy

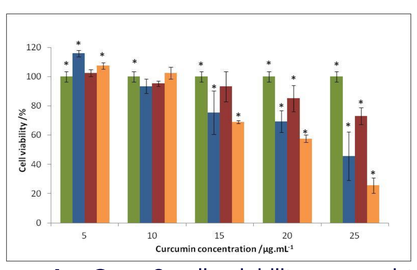


Figure 4 – Caco-2 cells viability exposed to free curcumin (■), NE (■) and SLN (■) assessed by MTT assay, after incubation for 24 h. All data sets were compared to positive control (■). * $p<0.05$ relatively to the mean positive control.

- MTT assay results demonstrated that NE and SLN, after 24 h incubation, showed no cytotoxic effects at curcumin concentration lower than 15 µg·mL^{-1}.

Conclusions

- Significant differences were observed in the behavior of lipid droplets in the liquid (NE) and solid (SLN) states throughout the *in vitro* digestion.
- Higher curcumin bioaccessibility was obtained for NE, which is probably related to the higher release of FFA found for this nanoformulation.
- The highest concentration of curcumin on both NE and SLN formulations that can be used without interfere with cellular viability is 15 µg·mL^{-1} after 24 h of exposure.
- This work contribute to the evolution of the state-of-the-art on the development of delivery systems with improved bioavailability and on the application of nanotechnology-based solutions in the food sector by gathering fundamental data on digestion and safety of different nanoformulations.

References

Minekus, M., M. Alminger, et al. (2014). "A standardised static *in vitro* digestion method suitable for food - an international consensus". Food & Function 5(6): 1113-1124.

Acknowledgements

Ana C. Pinheiro and Joana T. Martins acknowledge the Foundation for Science and Technology (FCT) for their fellowships (SFRH/BPD/101181/2014 and SFRH/BPD/89992/2012). This work was supported by Portuguese Foundation for Science and Technology (FCT) under the scope of the Project PTDC/AGR-TEC/5215/2014, of the strategic funding of UID/BIO/04469/2013 unit and COMPETE 2020 (POCI-01-0145-FEDER-006684) and BioTecNorte operation (NORTE-01-0145-FEDER-000004) funded by the European Regional Development Fund under the scope of Norte2020 - Programa Operacional Regional do Norte.