First approach on the stability and bioaccesibility of epoxy-resin contaminants from packaging materials in food

L. Pazos-Soto[1,2], P. Vázquez Loureiro[1,2], S. Mariño-Cortegoso[1,2], A. Lestido-Cardama[1], J. Bustos[3], P. Paseiro-Losada[1], A. Rodríguez-Bernaldo de Quirós[1,2], R. Sendón[1,2], L. Barbosa-Pereira[1,2]

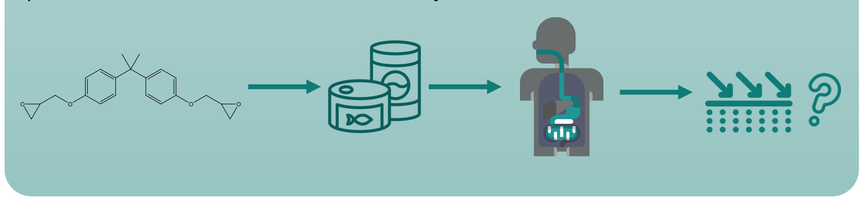
[1] FoodChemPack Research Group, Department of Analytical Chemistry, Nutrition and Food Science, Faculty of Pharmacy, University of Santiago de Compostela, Campus Vida, 15782 Santiago de Compostela, Spain
[2] Instituto de Materiales (iMATUS), University of Santiago de Compostela, 15782 Santiago de Compostela, Spain
[3] National Food Centre, Spanish Agency for Food Safety and Nutrition, 28220, Majadahonda, Spain

1 INTRODUCTION

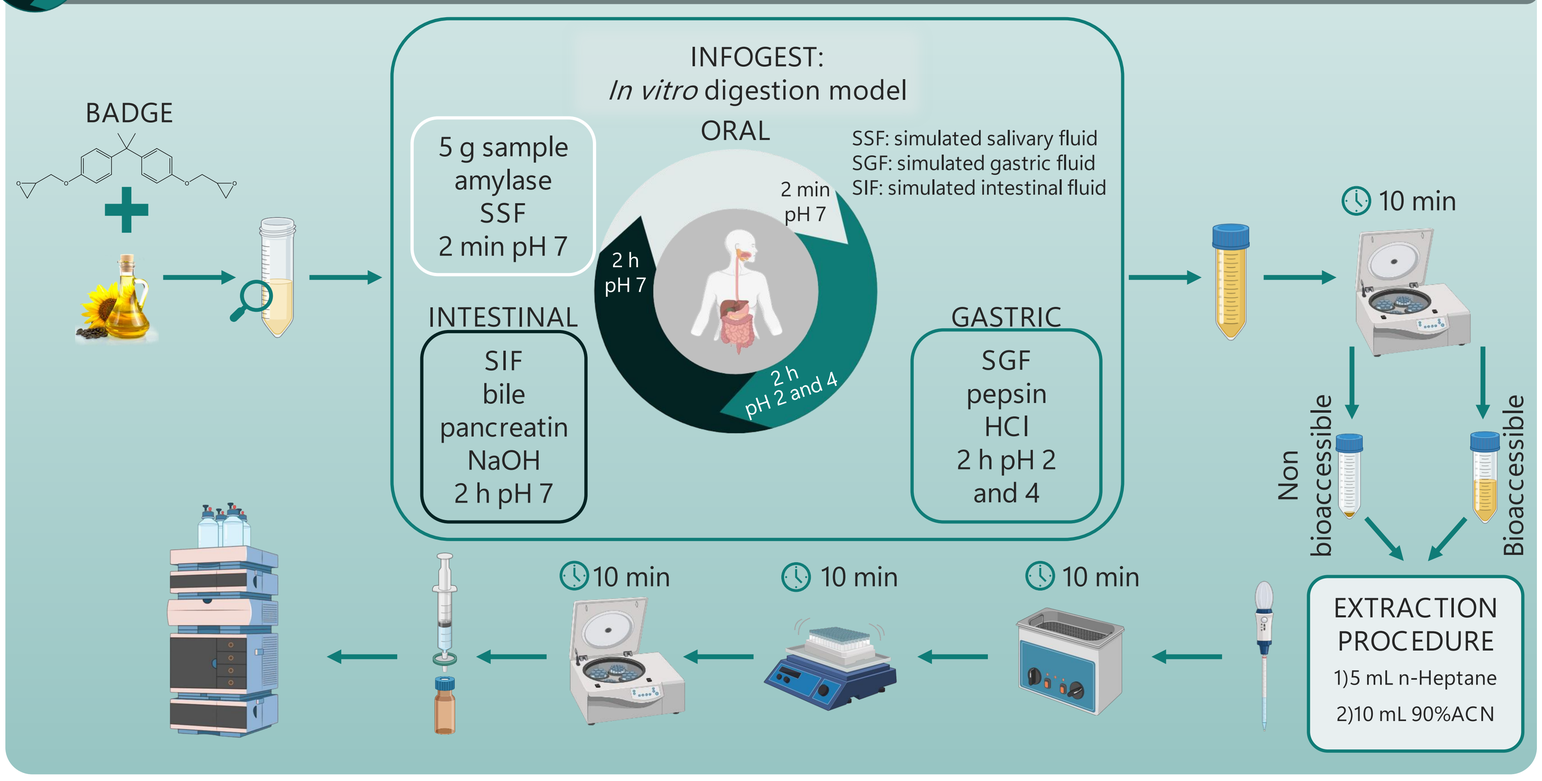
Epoxy-based coatings are applied to the inner surfaces of food and beverage metal cans. Bisphenol A diglycidyl ether (**BADGE**) is one of the substances most widely present in these coatings, and it is obtained by the reaction of bisphenol A (**BPA**) with epichlorohydrin [1]. During the polymerization process or when exposed to high temperatures, these chemicals present in food contact materials have the potential to **migrate** into the foodstuff [2].

Consumers' exposure to BADGE derivatives needs to be assessed, considering not just the total amount of contaminant present in the foodstuff but also the bioaccessible amount to be absorbed.

This work focuses on the determination of the chemical stability, solubility and **bioaccessibility** of BADGE using a validated *in vitro* gastrointestinal digestion protocol [3]. The main objective is to determine the influence of physiological variants, such as enzymes and pH values, on BADGE's bioaccesibility.



2 MATERIAL AND METHODS



3 RESULTS AND DISCUSSION

Table 1. Optimized chromatographic conditions

Chromatograph	Agilent HPLC system 1100 HP with FLD detector
Column	PhenoSphere 3 µm ODS(2) 80 Å, LC Column 150 x 4.6 mm
Mobile phase	Water and acetonitrile
Flow rate	1 mL/min
Injection volume	10 μL
Run length	26 minutes
Post-time	5 minutes
Detector wavelenght (FLD)	Excitation: 225 nm Emission: 305 nm
Column temperature	25 ºC

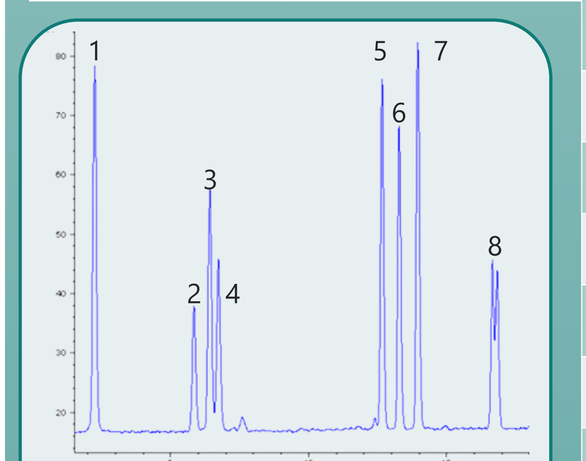
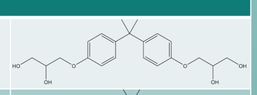
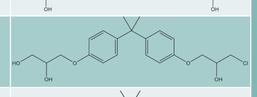
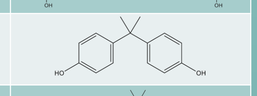
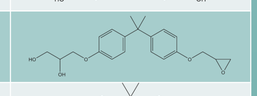
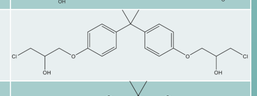
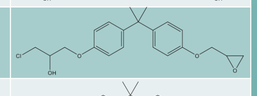
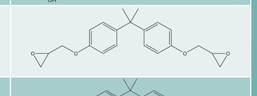
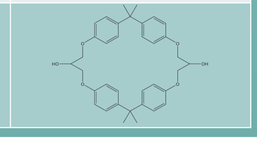


Figure 1. HPLC-FLD chromatogram of BADGE's derivatives.

Table 2. Chemical estructure of BADGE and derivatives

1	BADGE·2H$_2$O	
2	BADGE·HCl·H$_2$O	
3	BPA	
4	BADGE·H$_2$O	
5	BADGE·2HCl	
6	BADGE·HCl	
7	BADGE	
8	CicloDiBADGE	

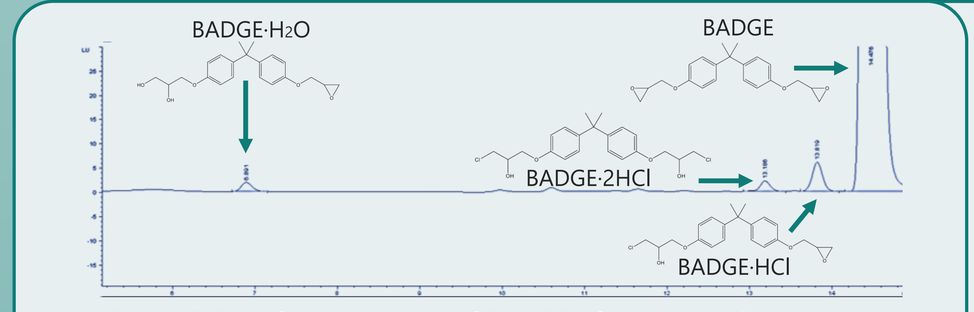


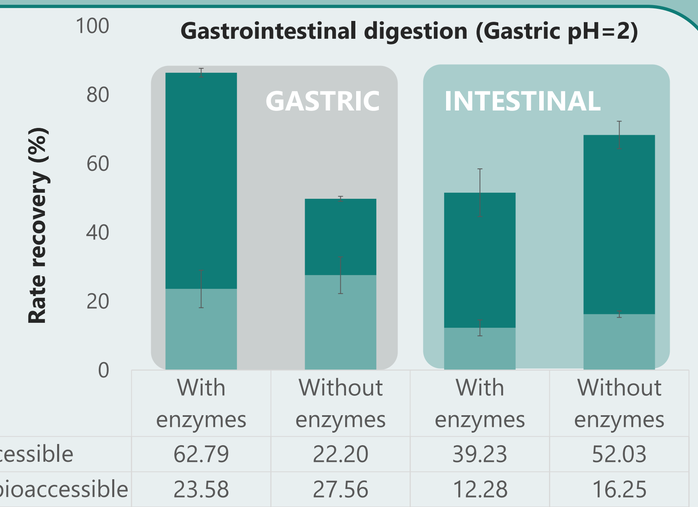
Figure 2. HPLC-FLD chromatogram of BADGE after gastric digestion (pH 4).

pH 2:
The presence of enzymes increases BADGE's solubility in the gastric phase. The solubility decreases in the intestinal phase with a final bioaccessibility of 39.2%.

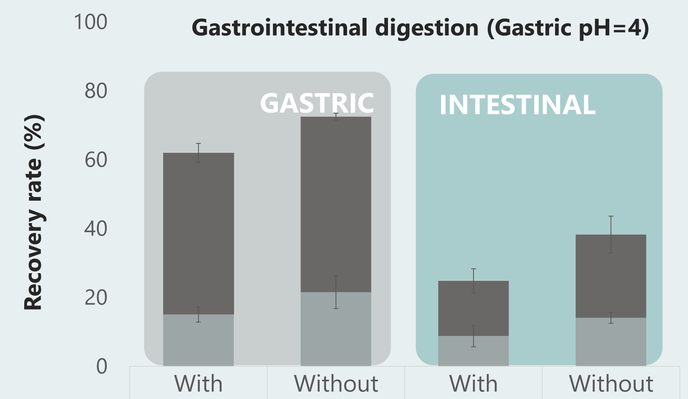
Considering the pH effect, in absence of enzymes, higher pH values results in greater solubility of BADGE in the intestinal phase.

pH 4:
The bioaccessibility of BADGE decreases significantly at intestinal level after complete digestion.

The contaminant is more soluble at gastric level, showing an inferior bioaccessibility than the obtained at pH 2.



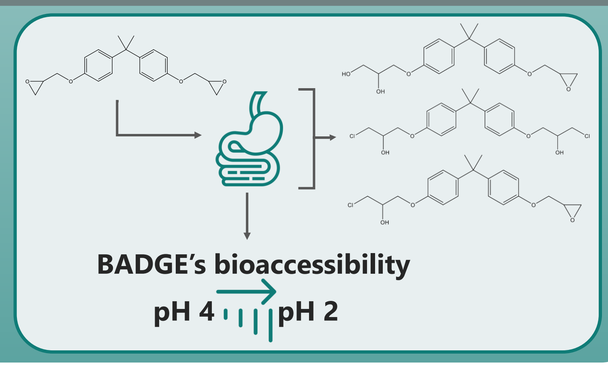
	With enzymes	Without enzymes	With enzymes	Without enzymes
Bioaccessible	62.79	22.20	39.23	52.03
Non-bioaccessible	23.58	27.56	12.28	16.25



	With enzymes	Without enzymes	With enzymes	Without enzymes
Bioaccessible	46.92	50.93	16.01	24.17
Non-bioaccessible	15.00	21.51	8.78	14.05

4 CONCLUSIONS

- → Based on chromatographic profiles, we observed the transformation of BADGE into chlorohydrin and hydrolysis derivatives during the gastric phase at both studied pH values. The molecules that have been identified are BADGE·H2O, BADGE·2HCl and BADGE·HCl.
- → The solubility of BADGE is affected by the different pH values and this impacts on the final bioaccessibility, that varies from **39,23%** at pH 2 to **16,01 %** at pH 4. Therefore, individuals with high pH values, such as elderly and children, are less exposed to these contaminants.
- → The presence of enzymes affects BADGE's bioaccessibility at both pH values due to the interactions between them and the conditions needed for the optimal activity of the enzymes.
- → Further research should be carried out to study different pH conditions and evaluate the effect of other food matrices on the BADGE-related compounds formation during gastrointestinal digestion with potential toxicity.



5 REFERENCES

[1] Poças, M. F., & Hogg, T. (2007). *Trends in Food Science & Technology*, 18, 219-230.
[2] Lestido-Cardama A, Sendón R, Bustos J, Nieto MT, Paseiro-Losada P, Rodríguez-Bernaldo de Quirós A. *Co23mpr. Rev. Food. Sci.* Food. Saf., 2022, 21(4), 3558–611
[3] Minekus M, et al. (2014). *Food & function*, 5, 1113-1124

6 ACKNOWNLEDGEMENTS

BACFood4Expo project (PID2020-114569RJ-I00) funded by Spanish Ministry of Science and Innovation (10.13039/501100011033) under the competitive State R&D Program Oriented to the Challenges of the Society, "R&D Projects 2020" - Modalities "Research Challenges and Knowledge Generation".

In vitro oral bioAccessibility of Chemicals from food contact materials to estimate Human Exposure through the Diet (ACHED) (CNS2022-135887) funded by Spanish Ministry of Science (10.13039/50110001103) and European Union NextGenerationEU/PRTR.

SCAN ME