Effect of the pH on the migration of ethyl-4-(dimethylamino) benzoate (EDB) into food simulants from LDPE

Lago, M. A.*[a]; Rodríguez-Bernaldo de Quirós, A.[a]; Sendón, R.[a], Santillana, M.I.[b], Bustos, J.[b], & Paseiro, P.[a]

miguelangel.lago@usc.es

[a] Department of Analytical Chemistry, Nutrition and Food Science, Faculty of Pharmacy, University of Santiago de Compostela, Santiago de Compostela, Spain.
[b] Spanish Agency for Consumer Affairs, Food Safety and Nutrition, Majadahonda, Madrid, Spain.

Introduction

After more than 150 food safety alerts and notifications published in the last decade by the Rapid Alert System for Food and Feed (RASFF) related to photoinitiators and amine synergists, their migration into food continues to be a common food safety problem concerning Food Contact Materials (FCM). The process of migration of these compounds have been scarcely studied in the last years; to the best of our knowledge, there are only migration kinetics data available for six photoinitiators (Benzophenone, Chimassorb 81®, ITX and Irgacures 184®, 651® and 907®) and one amine synergist (2-ethylhexyl-4-(dimethylamino) benzoate (EHA). For this reason, the aim of this study was to extend the knowledge about the migration kinetics of one of the most common amine synergist used as coinitiator in type II photoinitiating systems.

Methodology

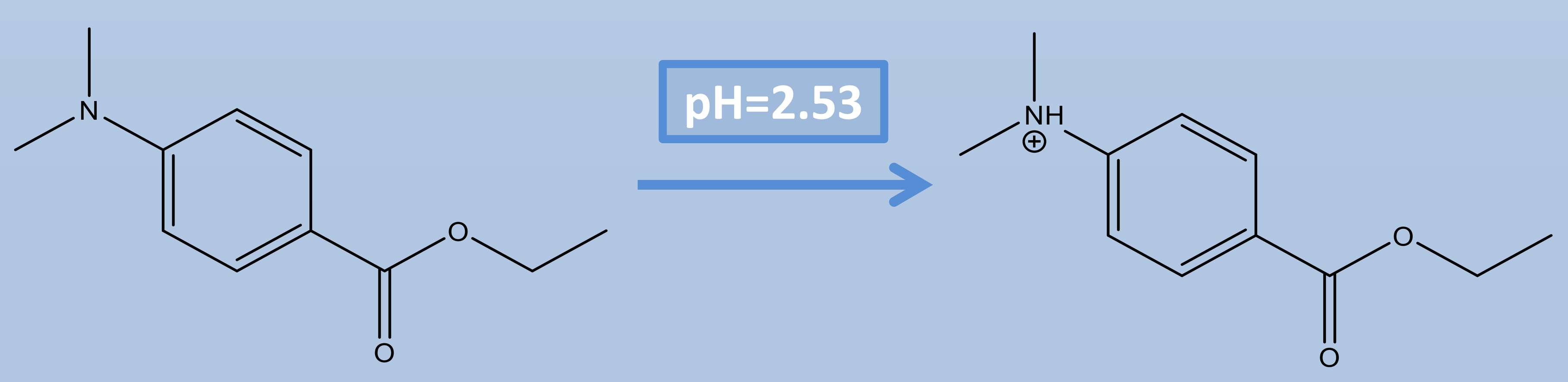
EDB was included in a LDPE matrix by extrusion. The film was cut and immersed in the food simulant, in tubes protected from the light, at 4 different temperatures: -18, 4, 20 and 40 °C by duplicate. An aliquot of the food simulant was removed from each sample at preset times and they were injected in an HPLC-DAD system, in order to quantify the migrant released at 308 nm. The chromatographic method was the same used by Lago *et al*. (1). The experimental data obtained in the migration experiments into the food simulants, were fitted with a proposed mathematical model based on the Crank solutions for this system.All this process is explained in the following scheme:

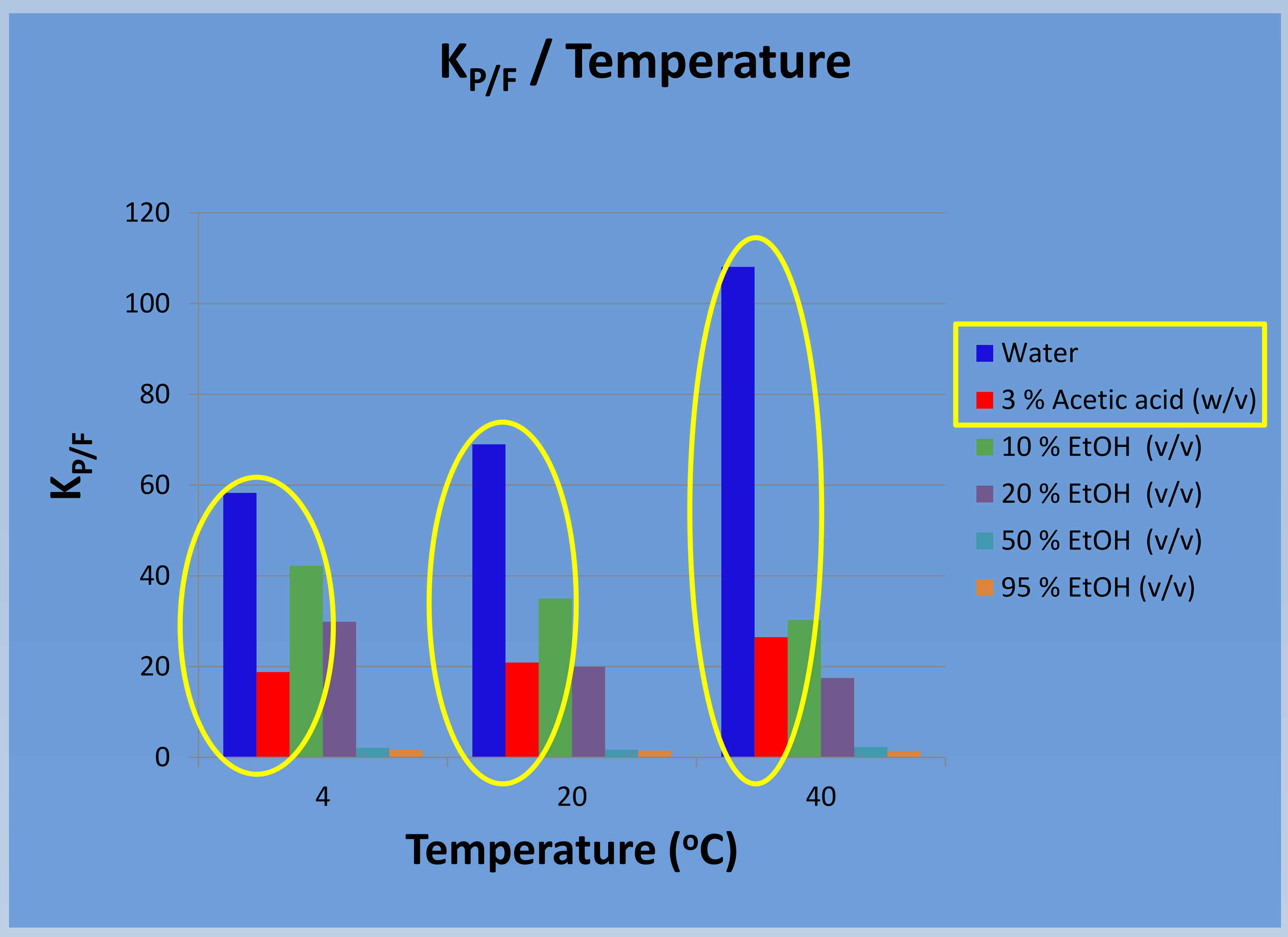
Results

Diffusion and partition coefficients (D_P and $K_{P/F}$) were estimated with this model based on Fick's 2nd law. The experimental data present a good fit between the obtained data and the mathematical model used (RMSE < 6.3 %).
The D_P values were highly dependent on the storage conditions and the $K_{P/F}$ values showed more affinity for the lipophilic food simulants than for the hydrophilic ones. However, the $K_{P/F}$ values in 3 % acetic acid (w/v) suggested more affinity for this acidic simulant than for water. Probably, this is due to the fact that at the 3 % acetic acid (w/v) pH value (2.53), 83 % of the amine is in the protonated form and this specie could migrate faster than the non-protonated coinitiator.

Temperature (°C)	D_P (cm^2/s)					
	Water	3 % Acetic acid (w/v)	10 % EtOH (v/v)	20 % EtOH (v/v)	50 % EtOH (v/v)	95 % EtOH (v/v)
-18					5.5E-13	7.8E-13
4	2.6E-10	4.6E-10	3.2E-10	3.9E-10	4.7E-10	4.0E-10
20	8.9E-10	2.1E-9	1.3E-9	1.5E-9	2.1E-9	2.8E-9
40	3.0E-9	6.8E-9	5.1E-9	1.2E-8	8.5E-9	6.4E-9

Temperature (°C)	$K_{P/F}$					
	Water	3 % Acetic acid (w/v)	10 % EtOH (v/v)	20 % EtOH (v/v)	50 % EtOH (v/v)	95 % EtOH (v/v)
-18					21.6	16.7
4	58.3	18.8	42.2	29.9	<2.1	<1.7
20	69.0	20.9	35.0	20.0	<1.7	<1.5
40	108.1	26.5	30.3	17.5	<2.3	<1.4





Conclusions

This work provides reliable data on the migration of EDB, one of the most used amine synergists used as coinitiator of type II photoinitiators in UV inks for food packaging.

The results showed that the process of migration is highly dependent on the storage conditions, the migrant properties and the pH of the foodstuff.

Acknowledgements:

The study was financially co-supported by the "Ministerio de Economía y Competitividad", Ref. No. AGL/2011-26531 "MIGRATIN" and "Fondo Europeo de Desarrollo Regional" "FEDER". Authors are grateful to "Ministerio de Economía y Competitividad" for the Predoctoral fellowship FPI (Ref. BES-2012-051993) awarded to M. A. Lago.

References:

1. Lago, M. A. & Ackerman, L. K. Identification of print related contaminants in food packaging. *Food Addit & Contam A*. 2016. 33(3):518-529.
2. Green WA. 2010. Industrial photoinitiators: a technical guide. Boca Ratón (FL): Taylor & Francis.