

# SPICA 2010

13<sup>th</sup> International  
Symposium on  
Preparative and  
Industrial  
Chromatography and  
Allied Techniques



Scientific Program

September 12<sup>th</sup> - 15<sup>th</sup>, 2010

Stockholm, Sweden

[www.spica2010.se](http://www.spica2010.se)

Kromasil®



# Equilibrium Studies of the Adsorption of Fructo-oligosaccharides from a Pure Mixture and a Fermentative Broth on a Dowex Monosphere Calcium Resin

C. Nobre<sup>a</sup>, K.Vaňková<sup>b</sup>, A. M. Peres<sup>c</sup>, M. Polakovič<sup>b</sup>, J. A. Teixeira<sup>a</sup>, L. R. Rodrigues<sup>a</sup>

<sup>a</sup> IBB – Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, Braga, Portugal

<sup>b</sup> Department of Chemical and Biochemical Engineering, Institute of Chemical and Environmental Engineering, Faculty of Chemical and Food Technology, Slovak University of Technology, Bratislava, Slovak Republic

<sup>c</sup> LSRE – Laboratory of Separation and Reaction Engineering, Escola Superior Agrária – Instituto Politécnico de Bragança, Bragança, Portugal

E-mail  
\*clarissenobre@deb.uminho.pt

## Introduction

- Fructo-oligosaccharides (FOS) gained in the last years a large commercial interest due to its beneficial properties in the human health as prebiotics.
- Fermentative processes appear to be a good alternative for large scale production of FOS, that include kestose (GF2), nystose (GF3) and fructo-furanosylnystose (GF4). However, the result of such fermentations is a complex mixture containing salts and low molecular weight sugars such as glucose (G), fructose (F) and sucrose (GF), that do not contribute to the beneficial effects and must be removed.
- Simulated moving bed chromatography (SMB) appears to be an efficient downstream process for the fractionation of sugars in an industrial scale. The major challenge when designing the separation process is the choice of an efficient ion-exchange resin. Therefore, the knowledge of the adsorption isotherms of the different compounds present in the mixture is an important parameter to consider when selecting the resin. Moreover, the influence on the adsorption of salts and other sugars present in the mixture must be studied.

## Aims

- Modelling of the adsorption isotherms for FOS (from fermentative broth and pure mixtures) onto a Dowex Monosphere calcium resin.
- Determination of the model isotherm parameters using linear and non-linear correlations by minimization of several error functions.

## Experimental Methodology

### Resin Characteristics

Dowex Monosphere 99Ca/320	
Ionic form	Ca <sup>2+</sup>
Structure	Gel-type
Matrix	Styrene-DVB
Functional group	Sulfonate
Total capacity (eq/L)	>1.5 (H <sup>+</sup> form)
Water content (%)	57-61 (H <sup>+</sup> form)
Volume median diameter (µm)	300-330

### Isotherm Models

Curvature	Isotherm Model
Linear	Linear
	Anti-Langmuir
	Langmuir
Downward	Freundlich
	Redlich & Peterson
	Toth
	Langmuir

### Isotherm Parameters Determination

#### Linear Correlation

Linearization of the Model Equations

#### Non-Linear Correlation

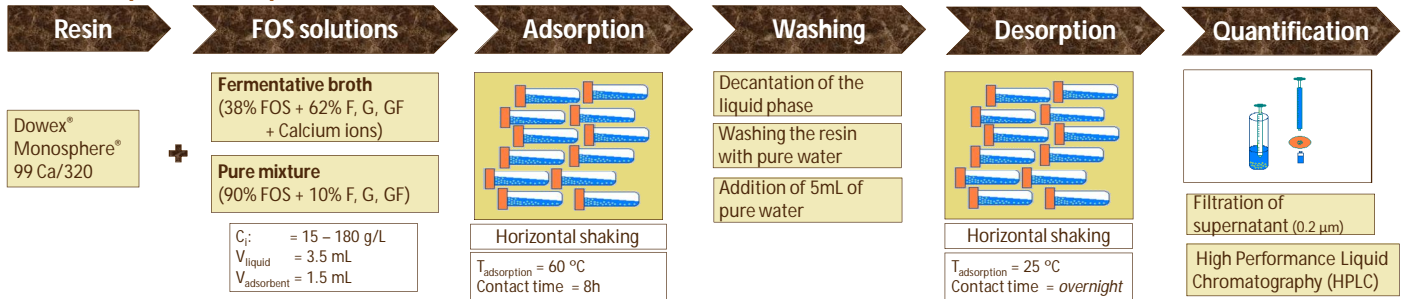
Minimization of several error functions

#### Error Function

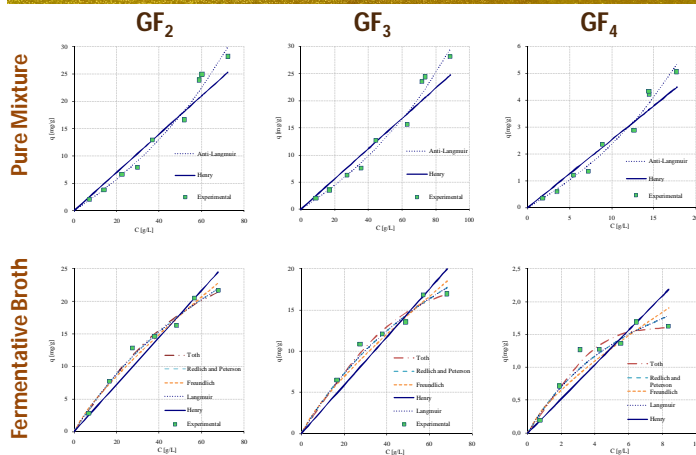
Sum square of the errors  
Hybrid fractional error function  
Marquardt's percent standard deviation  
Average relative error  
Sum of absolute errors

Smaller  
Sum of the Errors  
↓  
Best fitting of the  
experimental data

### Static - Adsorption /Desorption Method



## Results



Linear Distribution coefficients (L.kg<sup>-1</sup>)

	GF <sub>2</sub>	GF <sub>3</sub>	GF <sub>4</sub>
Fermentative broth	0,36	0,29	0,26
Pure mixture	0,35	0,28	0,25

## Conclusions

- FOS present in pure mixture or broth have different adsorption behaviors.
- High ionic strengths and high concentrations of the other sugars seems to influence the adsorption.
- Toth, Langmuir and Redlich & Peterson isotherms were the models that best represented the adsorption of FOS in the broth, while FOS in pure mixture were better represented by the Anti-Langmuir isotherm.
- For both mixtures studied, the sugars were adsorbed according to their molecular size and kept a constant selective behavior.
- The non-linear methods were found to be more adequate to estimated the isotherms parameters, being the HYBRID function the one that gives better the results.

## References

- GR Gibson (2008) J Clin Gastroenterol **42**:S75-S79
- M Gramblicka, M Polakovic (2007) J Chem Eng Data **52**:345-350
- J Nowak, I Poplewska, D Antos, A Seidel-Morgenstern (2009) J Chrom A **1216**:8697-8704
- M Saska, MD Wu, SJ Clarke, K Iqbal (1992) Sep Sci Technol **27**:1711-1732
- M Hadi, MR Samarghandi, G Mckay (2010) Chem Eng J **160**:408-416

## Acknowledgements

C. Nobre acknowledges the F.C.T. - Fundação para a Ciência e a Tecnologia (Portugal) for the PhD Grant ref. SFRH/BD/32514/2006.