New Surfactants from Agro-industry Side Streams

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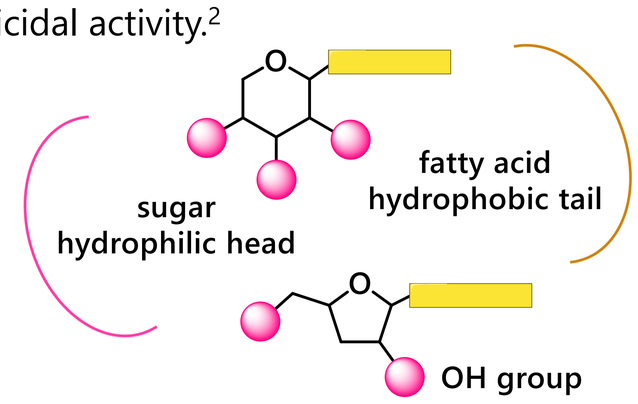
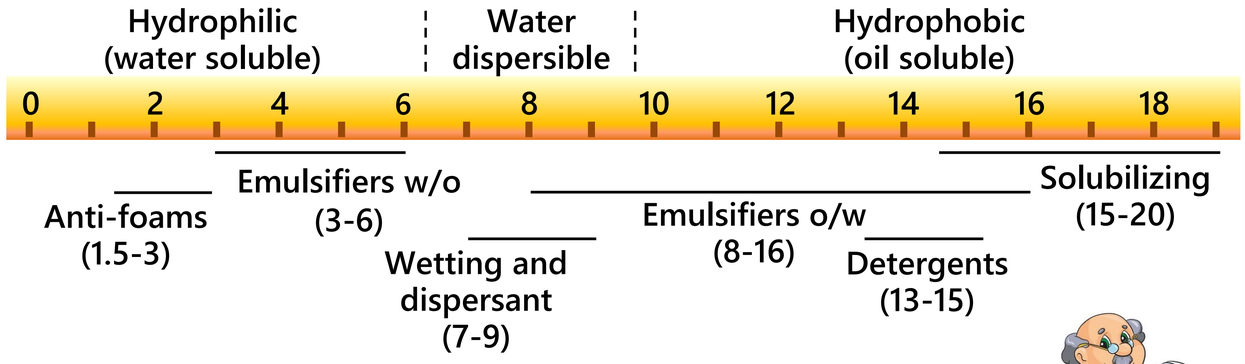
Introduction … SUGAR FATTY ACID ESTERS are amphiphilic compounds widely employed as biodegradable, food-grade, non-ionic surfactant at industrial level in place of the petrochemical-based ones.[1] They are easily digested as a mixture of sugars and fatty acids and some of them showed antimicrobial, anticancer and insecticidal activity.[2]



Their SURFACTANT PROPERTIES may be predicted using the hydrophobic-lipophilic balance (HLB) that depends on the degree of substitution and ratio between the sugar hydrophilic head and the length of the fatty acid lipophilic tail.

$$HLB = M_{hydrophilic\ moiety} / M_{total}$$



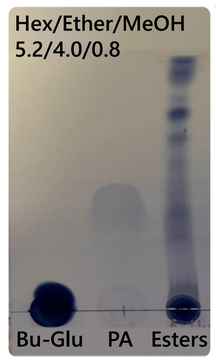
The SYNTHESIS is usually developed by both chemical or enzymatic routs. Enzymes are usually preferred for the highest regioselectivity and the mild and safe reaction conditions. However, sugar monoesters are obtained as main products and the yields are low and strongly affected by the choice of reaction medium.

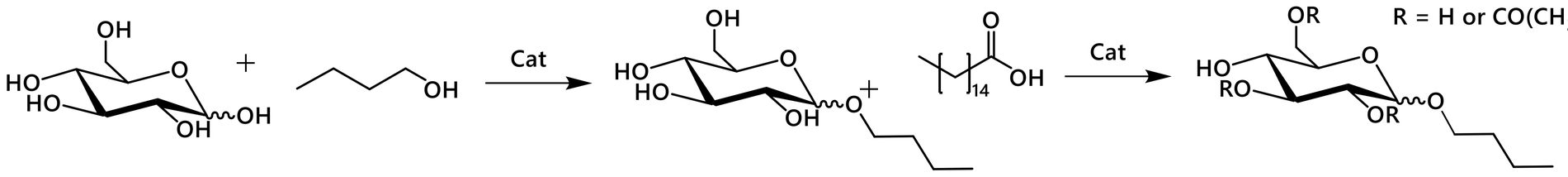
In the framework of project AnimalFatPlus we are synthesizing new surfactants deriving from the sidestreams of the cereal industry, namely MALTOSE and GLUCOSE, and of the meat industry, namely FATTY ACIDS, through a heterogeneous catalytic approach basing on our expertise in the esterification of the monosaccharides arabinose and glucose together with palmitic acid.[3,4]

AnimalFat+

Heterogeneous Catalysis

… ***Results*** … To overcome the striking different polarity of sugars and fatty acids, we converted maltose into a less polar derivative through derivatization with the green solvent *n*-ButOH using Amberlyst®15 as the heterogeneous catalyst.[5] The *n*-butyl glucoside obtained was then esterified with palmitic acid in a solvent-free reaction in the presence of a different polystyrene sulphonic resin. As the TLC and ATR-FTIR (fig A) analyses show, we obtained a reproducible mixture *n*-butyl glucoside/palmitic acid esters in 40% yield.

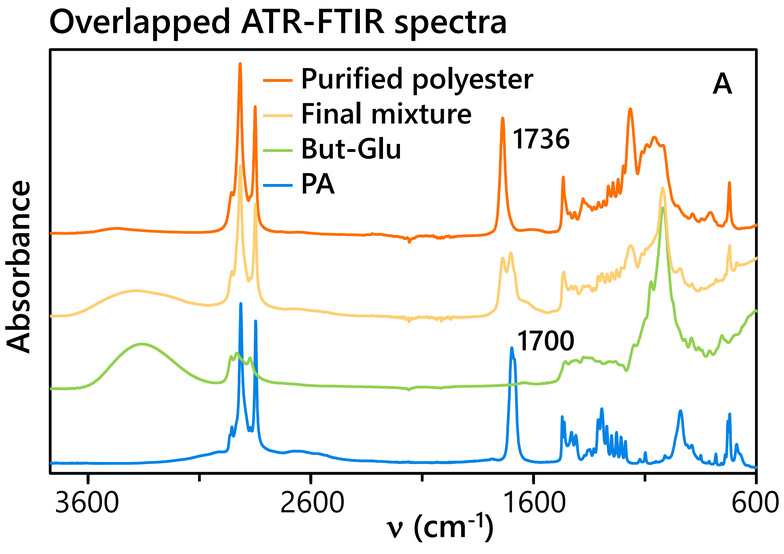




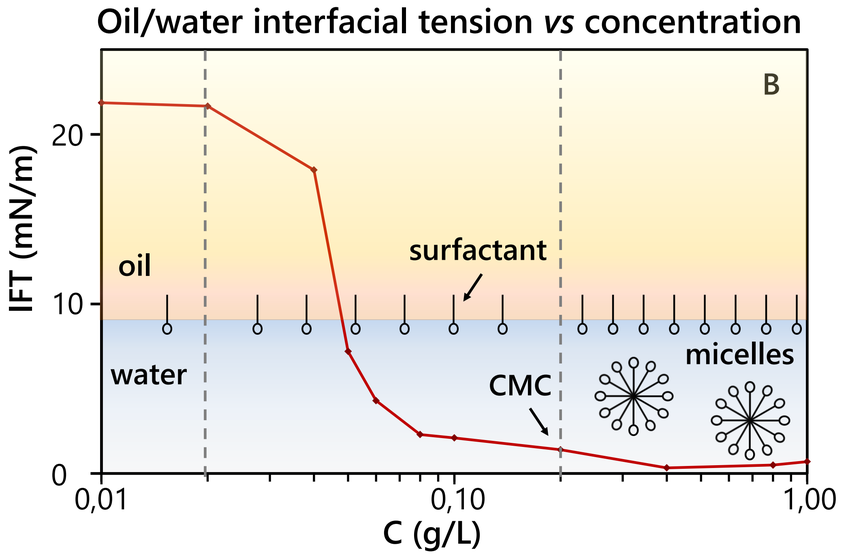
Thanks to Prof. Cappelletti for characterization measurements

… ***Characterization*** … The physico-chemical properties of the final product, in terms of sunflower O/W interfacial tension (IFT), W/O emulsifying capability and stability over time, have been investigated. Graph B shows that *n*-butyl glucoside polyesters reduce the IFT of around 20 mN/m with a critical micelle concentration (CMC) of 0,2 g/L. Moreover, it is efficient to stabilize W/O emulsions and avoids the sedimentation with ageing (graph C).

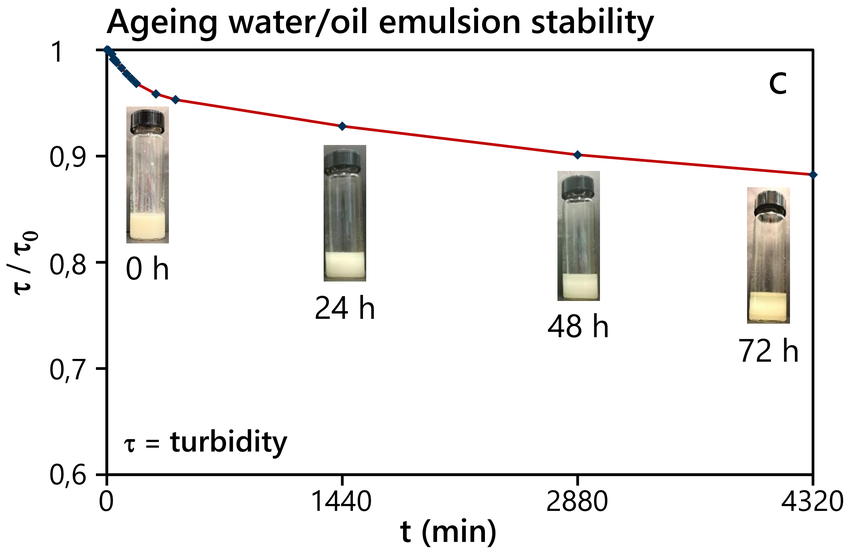
Overlapped ATR-FTIR spectra



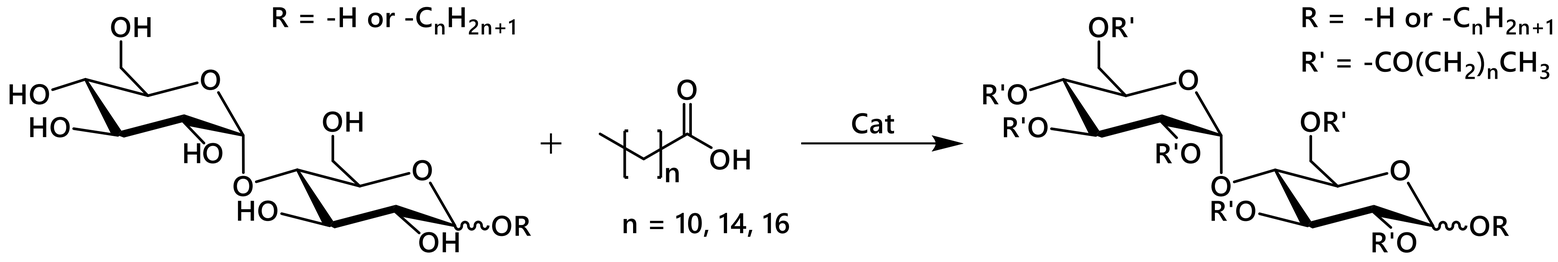
Oil/water interfacial tension *vs* concentration



Ageing water/oil emulsion stability



… ***In progress*** … We are planning the best way to produce maltose fatty acid esters by evaluating the activity of both mixed oxides and polystyrene sulphonic resins either by the method described above or by direct esterification.



… ***Acknowledgement*** … This work is part of the research project *AninalFatPLus, Healthier meat products with less saturated fat, and novel utilization of excess animal fat combined with carbohydrate-rich side-streams*, funded by the Norwegian Research Levy on Agricultural products and the Agricultural Agreement Research Fund.

[1] Van Den Broek LAM & Boeriu CG, **2013**, *Carb Polym*, 93, 65. [2] Xin L, **2014**, *J Chem Pharm Res*, 6(5), 944. [3] Pappalardo VM, Boeriu CG, Zaccheria F, Ravasio, N, **2017**, *Mol Catal*, 433, 383. [4] Pappalardo VM, Zaccheria F, Ravasio, N, *et al*, **2020**, *ChemistrySelect*, 5(26), 8009. [5] Cappelletti G, Speranza G *et al*, **2022**, *Colloid and Interface Science Communications*. 48. 100630.