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Lipase-catalyzed synthesis and physico-chemical characterization of alkyl glycoside fatty acid esters from cheese whey permeate

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PURPOSE OF THE ABSTRACT

Sugar fatty acid esters (SFAEs), usually called sugar esters, are a class of non-ionic surfactants, characterized by excellent emulsifying, stabilizing and detergency properties. These compounds have many advantages over petrochemical-derived surfactants: SFAEs are odorless, tasteless, fully biodegradable, skin-compatible, non-toxic and non-harmful to the environment. Moreover, both the constituent moieties, sugars and fatty acids, can be produced from renewable agricultural resources, i.e. from biomass such as cheese whey permeate and oil wastes, respectively. Depending on carbon chain length, degree of esterification and nature of the sugar head group, SFAEs could cover a wide range of hydrophilic-lipophilic balance (HLB) values, thus resulting in tunable surfactant properties and becoming candidates for many possible applications, such as O/W or W/O emulsifiers, solubilizing agents, lubricants, penetrating enhancers and pore forming agents. Indeed, these biosurfactants are of great interest in many market sectors (i.e. food, detergent, cosmetic and pharmaceutical industry). [1]
However, the chemical synthesis of SFAEs is not environmentally friendly as it requires harsh reaction conditions (hazardous solvents, high temperatures, acid or base catalysts) resulting in high energy consumption, formation of undesirable by-products (e.g. due to caramelization of sugars) and low selectivity. [2]
Enzymatic strategies appear to be a promising alternative to simplify both product synthesis and downstream. [3]
We present here the chemoenzymatic synthesis of a library of alkyl glycoside fatty acid esters (Figure 1) prepared by Fisher glycosylation of glucose and galactose (easily obtained from enzymatic hydrolysis of cheese whey permeate) with naturally occurring alcohols under acidic catalysis (Amberlyst® 15), followed by lipase-catalyzed esterification of the resulting isomeric mixtures of alkyl glycosides (namely α-/β-D-glucosides and α-/β-D-galactosides). CalB (Novozym® 435) was used as a biocatalyst in a highly sustainable and easily scalable solvent-free system. Conversion of glucose and galactose into alkyl glycosides before the esterification reaction played a key role in circumventing the striking different solubility of the two reagents.
The influence of the sugar polar head (glucose vs galactose), of the tail chain length (C12 vs C16 vs C18) and of the ring size (pyranosides vs furanosides) on the physico-chemical properties of the synthesized tensides (interfacial tension features, W/O emulsification capability and W/O stability over time) was evaluated. [4]

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FIGURES

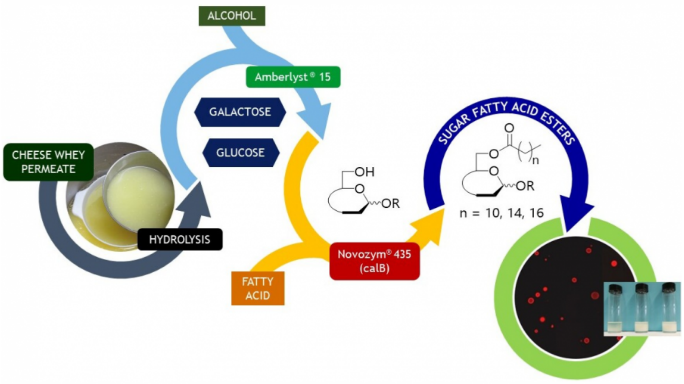

FIGURE 1

Figure 1

Chemoenzymatic strategy for the synthesis of SFAEs from cheese whey permeate

FIGURE 2

KEYWORDS

SUGAR FATTY ACID ESTERS (SFAEs) | BIOSURFACTANTS | CHEESE WHEY PERMEATE | SUSTAINABLE PROCESS

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