

Enzymatic Synthesis of Sugar Fatty Acid Ester

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1. Introduction:

Sugar fatty acid esters are a class of non ionic surfactant that are non toxic, non irritant and biodegradable in nature. These chemicals are widely used as commodity chemicals in food, pharmaceutical, detergent and cosmetic industry [1]. Penta Erythritol Mono Ricinoleate (PEMR) is a sugar ester that has high potential to use as a raw material for production of lubricants, plastic lubricant/dispersant, bio-surfactant etc. Chemical methods used for synthesis results in formation of mixture of products such as Pentaerythritol MonoRicinoleate, Pentaerythritol DiRicinoleate, Pentaerythritol TriRicinoleate etc along with free fatty acids. Also synthesis of these compounds is carried out at higher temperature in presence of alkaline catalyst which leads to formation of colored products, degradation and, polymerization of product [2]. The increasing thrust towards green chemistry and use of milder reaction conditions makes enzyme based transformations more acceptable. The present study aims at development of enzymatic process for synthesis of PentaErythritol MonoRicinoleate (PEMR) using immobilized lipase system. Using immobilized enzyme system synthesis of PentaErythritol MonoRicinoleate (PEMR) with more than 71 % molar yield was achieved.

2. Material and Methods:

Chemicals: Commercial enzyme Novozym 435 from Novo Nordisk, Ricinoleic acid (RA) and Pentaerythritol (PE) from ACME Synthetic Chemicals, India, All solvents used were purchased from S.D Fine Chemicals Limited, Molecular sieves (3^oA) from Himedia and TLC plates (25cmX25cm) from MERCK were used.

Reaction was carried out by mixing PentaErythritol and Ricinoleic acid with activated molecular sieves in the selected solvent in 100 ml glass stopper flasks at 200 rpm shaking and 60^o C temperatures in an orbital shaker. Esterification was initiated by adding the enzyme. Molar conversion was calculated with respect to decrease in concentration of Ricinoleic acid as well as with respect to amount of formed PentaErythritol MonoRicinoleate (PEMR).

Analysis was carried out using reversed phase HPLC (Agilent 1200 Chromatography System) using Agilent Zorbax SB-18 (250 mm X 4.6 mm) column with UV detector.

3. Significant Results and Discussion

Several key reaction parameters that affect reaction kinetics and yields were studied. Selection of an appropriate solvent is of prime importance when the substrates differ considerably in terms of polarity and solvent affinity. In the present work solvents differing in their hydrophobicity were screened for synthesis of PEMR. Tert-butyl alcohol showed better yield and conversion and hence selected as solvent of choice for further studies. Different immobilized lipase preparations were evaluated for their

PEMR synthesis efficiency and non specific Novozym 435 gave highest yield. Enzyme catalyzed reactions are reversible in nature therefore substrate concentration and molar ratio were optimized to shift reaction equilibrium toward PEMR synthesis. Synthesis of PEMR leads to formation of water as by product which shifts the reaction towards hydrolysis that reduces overall conversion. The catalytic activity of lipase is influenced by hydration state of its microenvironment. In order to control amount of water in reaction course, effect of molecular sieves was studied and presence of molecular sieve had a positive impact on PEMR synthesis. Using Novozym 435 lipase, tert-butyl alcohol as solvent conversion of more than 71% was obtained in presence of molecular sieves.

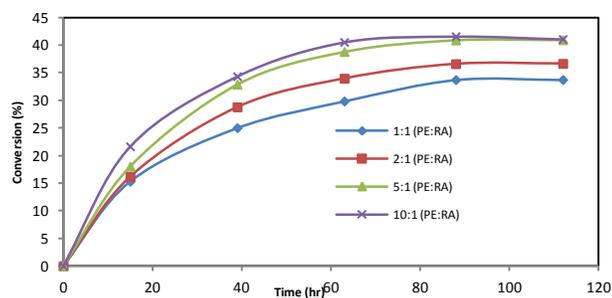


Figure 1: Effect of molar ratio of PE: RA on synthesis of PEMR

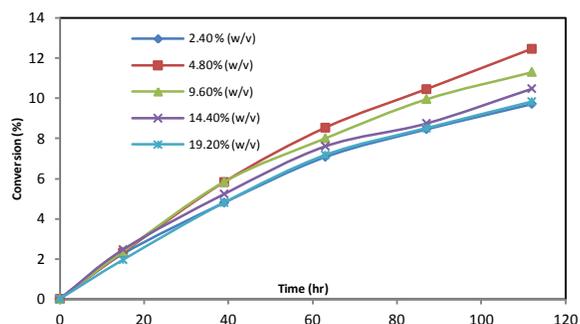


Figure 2: Effect of substrate concentration on synthesis of PEMR

4. Conclusions:

Chemical methods used for synthesis of sugar esters suffer from poor selectivity and results in formation of mixture of products. Enzymatic methods can overcome these drawbacks which make them attractive for synthesis of many commercially useful products not possible using chemical catalysis. Compounds such as PEMR as well as related molecules have the potential to be used at a large scale as biosurfactants and therefore there is a huge scope for rational designing of synthesis strategies.

References

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