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ENZYMIC INTERESTERIFICATION

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Introduction

Microbial lipases are used as catalysts for enzymic interesterification of oils and fats. The natural function of lipases is to catalyse the hydrolysis of acylglycerols and other fatty acid esters, but these reactions are easily reversible and consequently the enzymes are also effective catalysts of various interesterification reactions. Lipase catalysed interesterification of mixtures of triacylglycerols or triacylglycerols plus fatty acids can be used to modify oils and fats. By exploiting the selectivity of lipases high value speciality oils and fats which are difficult to obtain by alternative methods can be produced, and commercial processes for the production of confectionery and nutritional fats have been developed. Comprehensive reviews of enzymic interesterification have been published (1,2).

Catalysts

Enzymic interesterification reaction systems consist of the lipase catalyst and a very small amount of water dispersed in a continuous organic phase comprising the reactants and optionally a solvent such as hexane. Lipases catalyse reactions at interfaces, and a large interfacial area between the reactants and the more hydrophilic enzyme phase is required to obtain high reaction rates. This can be achieved by immobilising the lipases on the internal surfaces of macroporous support particles. Additional advantages of immobilised lipases are that they can be used in packed bed reactors and easily recovered from stirred tank reactors for reuse. To produce effective interesterification catalysts selection of suitable lipases and support materials is essential. As regards the lipases, the main criteria of suitability are selectivity, activity and stability in the reaction systems, and cost. For the support materials important parameters are surface properties and area, pore and particle size, compressibility, resistance to attrition, and cost. Both the lipases and support materials must be acceptable for use in food processing. Effective interesterification catalysts have been prepared by immobilising lipases on macroporous hydrophobic particles and weak anion exchange resins.

Reaction systems

For enzymic interesterification mixtures of triacylglycerols or triacylglycerols plus fatty acid (ester) are contacted with immobilised lipase catalyst in the presence of a small amount of water at 40-70°C. The reactions are preferably run without solvent, but in some cases hexane must be added to ensure that the reactants and products are liquid at the required reaction temperature.

Processes can be operated either in batches using stirred tank reactors or continuously with packed bed reactors. Packed bed reactors are usually preferred, because higher catalyst productivity and better product quality and yields can be achieved. For operation of packed bed reactors a small amount of water is dissolved in the reactant mixture, which is then pumped continuously through a bed of immobilised lipase particles. Careful control of the water content of the feed to the reactors is required to maintain catalyst activity whilst limiting the formation of hydrolysis by-products. Immobilised lipase catalysts can be very stable under the conditions found in packed bed reactors, and operation of reactors at temperatures up to 70°C for prolonged periods is possible. An important cause of catalyst inactivation is the presence in oils of minor components which destroy lipase activity, and to run processes cost effectively with long catalyst lifetimes and high productivity these catalyst poisons must be removed from the reactants by careful refining.

Applications

To date, enzymic interesterification has been used commercially for the production of high value speciality triacylglycerols. In the confectionery fat area, the 1,3-regioselectivity of lipases was exploited in the development of a process for the production of a fat containing a high concentration of 1,3-distearoyl-2-monoolein. This fat could be used as a substitute for shea stearine in the formulation of cocoa butter equivalents. Fats designed to inhibit bloom formation in chocolate products have also been produced by enzymic interesterification. In the area of nutritional fats, the technology is used to produce a human milk fat substitute for application in infant formula. Interesterification of a mixture of palm stearine and oleic acid using a 1,3-regioselective lipase catalyst gives triacylglycerols rich in 2-position palmitate with oleate in the 1,3-positions. These triacylglycerols have a fatty acid distribution similar to that found in human milk fat. Enzymic interesterification can also be used to produce oils and fats containing nutritionally important PUFAs such as eicosapentaenoic and docosahexaenoic acids. For example, use of the technique to produce structured lipids with medium-chain fatty acids and PUFAs located specifically at either the 2- or 1,3- of triacylglycerols has been described. In principle enzymic interesterification can be used as an alternative to chemical interesterification in the production of spreads and shortenings. However, because of high catalyst and processing costs, to date the technology has not been applied commercially for the production of these lower value fats.

References

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