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Enzymatic production of trans free fatty acid with high active and reusable enzyme.

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Highlights

- Nanoparticles Magnetic support
- Free TFAs
- High activity
- Enzyme stability and reusability.

Introduction

Hardening of unsaturated fatty acids (FA) through catalytic hydrogenation is a fundamental industrial reaction carried out worldwide on very large scale since the early 1900s to manufacture basic oleochemicals, such as stabilizers and surfactants, and edible fats, such as margarine [1]. From the beginning, the hydrogenation of FA has been heterogeneously catalyzed with Ni in suspension, at relatively high H_2 pressure (15-20 bar) and elevated temperature (180-230 °C), followed by the removal of the catalyst by time-consuming filtration with frequent Ni-soaps formation. Under these conditions nickel can indeed react with components of the fat to form fat-soluble salts which may contaminate the product, while a significant degree of cis/trans isomerization leads to formation of unhealthy trans fatty acid chains [2]. In recent years oxidoreductase enzyme have been attracting interest of chemistry for its high potential of hydrogenation. On the other hand, also in these process TFAs are generated, even a lot of efforts have been made to minimize formation of TFAs. Based on the health consequences of trans fatty acids (TFAs) consumption. WHO has recently concluded that ‘‘The new information was deemed sufficient to recommend the need to significantly reduce or to virtually eliminate industrially produced TFA from the food supply in agreement with the implementation of the 2004 WHO Global Strategy on Diet, Physical Activity and Health’’ [3]. These TFA residues appear to be at least as bad as saturated fatty acid (SFA) residues with respect to increasing the risk for heart disease, and may also increase infertility in women. Several countries have adopted measures limiting the TFA content of foods. With the increasing concerns of TFAs, development of the technology to remove TFAs from partial hydrogenated vegetable oils is of both academic and industrial interest. Technically it is possible to design a process approach to isolate TFAs in a mixture of saturated, unsaturated and trans fatty acids based on their differences in melting points and solubility in different solvents. However, it is impossible to remove TFAs from partially hydrogenated vegetable oils just by means of physical property difference, because these fatty acids are bound to glycerol backbone randomly. A possible solution to this challengeable problem is using a TFA-selective enzyme that is able to selectively hydrolysis TFAs as free fatty acids, and the released free fatty acids can be easily removed by saponification or membrane separation. To attain target fat, the resulting glycerides can be re-esterified with desired fatty acid profile that can generate preferable property. In the present work, the performance of *Candida Antarctica A* (CAL-A) immobilized on magnetic support for removal of TFAs from vegetable oil partially hydrogenated through a process of hydrolysis were evaluated. The use of magnetic nanoparticles to anchor the enzyme allows to easily recovery and reuse. Moreover, taking advantages from the surface nature of the nanoparticles, presenting simultaneously hydrophilic and hydrophobic characters enhanced enzyme activity through interfacial activation was observed. The immobilized enzyme shows activity higher than that of the free counterpart [4].

2. Methods

A wide characterization was performed using physico-chemical techniques: Transmission Electron Microscopy (TEM), thermogravimetric analysis (TG-DTG), FT-IR spectra, XRD measurements and GC–MS.

3. Results and discussion

The enzyme was immobilized through a simple and green procedure. It shows high enzymatic activity and stability resulting less sensitive to the temperature and pH changes than the native counterpart. Immobilized CAL-A on Fe_3O_4 NPs show high yield than the free counterpart to remove TFA during hydrolysis.

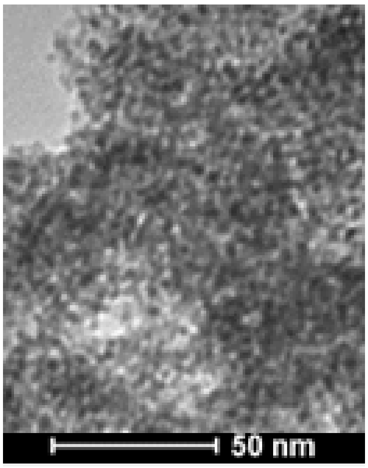

Figure 1. TEM image of Fe_3O_4 NPs.

4. Conclusions

Highly uniform size NPs that, once deposited over a TEM grid, due to oleic acid chains tend, to self-organize in a hexagonal layer, were prepare by a promising synthetic approach. Magnetic *Candida Antarctica A* lipase catalyst, utilizing Fe_3O_4 monodispersed nanoparticles as support, was developed. The enzyme was immobilized through a simple and green procedure. The very high enzymatic activity and stability showed by our biocatalyst, obtained through a one-step immobilization process. Biocatalyst show high selective for remove TFA in vegetable oil partially hydrogenation.

References

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Keywords
Fe_3O_4 NPs, candida antarctica lipase A, free trans fatty acid, interfacial activation