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BIODIESEL SYNTHESIS FROM WASTE LIPIDS CATALYZED BY IMMOBILIZED LIPASES

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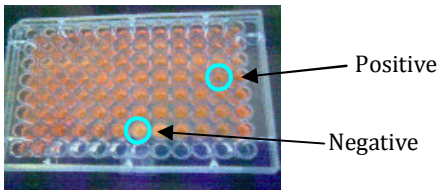
Introduction. Biodiesel, a mix of alkyl esters of long chain fatty acids, appears to be one of the best alternative biofuels (1). The raw material represents about 88% of the production cost of biodiesel (2), being the high prices of vegetable oils a disadvantage on the market. The use of waste or recycled oils and greases contributes to reduce the biodiesel cost and to avoid ethical controversies of using agricultural lands for biofuel crops. The lipase-catalyzed process is specially adapted to produce biodiesel from waste oils because the free fatty acids are directly esterified into biodiesel (3), avoiding saponification and corrosion, common problems in the well-known base-catalyzed process. Additional advantages of the enzymatic process are safety and green processes, while the main drawback is the cost of the enzyme. Still, this drawback can be overcome by recycling the enzyme or by producing the enzyme in-house.
The objective of this work is to obtain immobilized lipases with high performances for the bioconversion of waste pig and beef tallow and recycled coconut oil into biodiesel.

Methods. Lipases from yeast and fungus were screened with a specially designed rapid test based on their activity and selectivity towards the targeted substrates (3). Selected lipases were produced by submerged fermentation and immobilized by adsorption and chemical linkage. Ethanol inhibition and solvent effects on immobilized lipases were assayed by a rapid spectrophotometric method (4). Finally, selected biocatalysts were tested on biodiesel synthesis from waste lipids and ethanol and the biodiesel product was characterized according to ASTM D6751 and European EN14214 standards for B100. Lipase performances and biodiesel produced were compared to those obtained by the commercial immobilized lipase Novozyme 435.

Results and discussion. 30 yeast and fungus from CIATEJ collection were screened using a specially designed test for synthetic activity of lipases (3) (figure 1).

Figure 1. *Screening for synthetic activity of lipases (3).*



Yarrowia lipolytica lipase (YLL) was selected for its high extracellular lipase activity. YLL was immobilized on several supports and the best support was selected on the basis of their activity and stability (4). The best support was a cationic macroporous resin. Reaction rate and conversions obtained by YLL were similar to those obtained with Novozyme 435 (N435). In table 1, it can be observed that biodiesel produced by YLL fits better the ASTM D6751 and EN14214 standards than biodiesel produced by N435. Solidification temperature was also lower in YLL biodiesel.

Table 1. *Properties of biodiesel from waste pig tallow obtained by YLL and N435 after removal of glycerol-aqueous phase by simple centrifugation*

Property	YLL	N435	Reference value
Residual ethanol (%mol)	0.26	0.44	0.20 max [a]
Total glycerol (% w/w)	0.00	0.04	0.24 max [b]
Acid number (mg/g)	0.59	0.71	0.50 max
Iodine value (g/100g)	24	43	120 max [c]
Fusion temperature (ºC)	6	10	N.S. [d]

[a] Not specified in ASTM D6751 and specified for methanol in EN 14214.
[b] 0.25 % mol/mol in EN 14214.
[c] Not specified in ASTM D6751, specification is for EN 14214.
[d] Not specified in standards, but it is important in cold weathers.

Conclusions. Among lipases tested, *Yarrowia lipolytica* lipase (YLL) immobilized on a cationic macroporous resin was the best biocatalyst for biodiesel synthesis from waste lipids. Parameters for biodiesel produced by YLL fit better to standards than those of biodiesel produced by Novozyme 435. YLL is therefore a new promising biocatalysts for biodiesel synthesis.

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