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Wax ester production from waste fish oil

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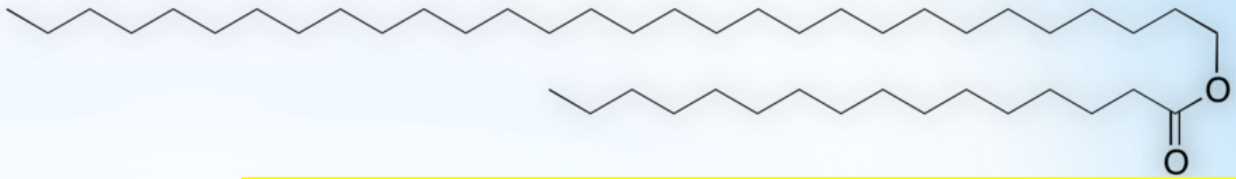
*Introduction



Wax esters are high-molecular-weight esters constituted of alcohols and fatty acids with more than 12 carbons atoms.

They are liquid or solid at ambient temperature, depending on the number of unsaturation, and low viscous fluid under slight temperatures increase.

The demand for waxes was of about $5 \cdot 10^6$ tons in 2010 and is continuously increased over the years.

Advantages

- non-toxic
- biodegradable
- can be extracted from animal and plant materials such as beeswax, spermaceti oil and jojoba oil.
- are significant ingredients in a lot of products: lubricants, candles, coatings, packaging and cosmetics

Disadvantage

- costs and availability of this resources

which has hindered the large-scale application of wax ester synthesis

The valorization of wastes and biomasses, is a valid and promising alternative, avoiding long treatment to minimize environmental impact

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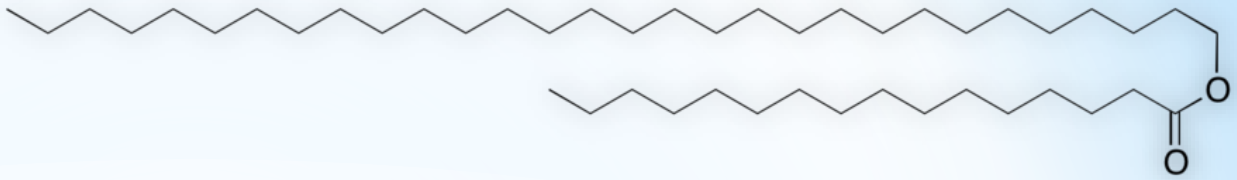


During fish processing operations, a significant amount of fish by-products as wastes is generated in the form of viscera, frame, head, skin scales, etc.

Although, some parts of these processing wastes are utilized as low cost ingredients:

- in animal feed production
- as fertilizer

the main bulk is looked as worthless garbage and dumped into the river or landfill, creating both disposal and pollution problems.

It is worth noting that:

- the visceral masses have high oil content (2–35 wt.%).

On the other hand, although, fish oil possesses several health benefits, due to the presence of omega-3 (eicosapentaenoic (C20:5 n-3) and docosahexaenoic acids (C22:6 n-3)), fish oils contain only 15–20% of omega-3 fatty acids, while the remaining oil remains unusable.

Besides, fish oil extracted from fish wastes may not meet the quality criteria required for edible purposes.

*Introduction

The most promising and effective current technology for wax ester production is the esterification or **transesterification** of oils with alcohol.

Catalyst → **Enzyme**

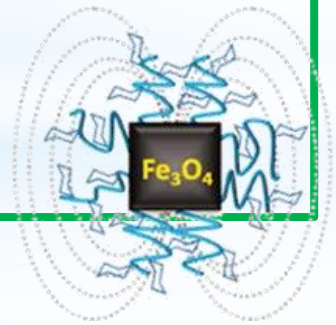
- Insensitive to free fatty acid (FFA)
- The oil does not require a pre-treatment
- Moisture content in the raw oil does not degrade the reaction

- Cost of enzymes
- "Eco-friendly"
- Difficult to recover and reuse

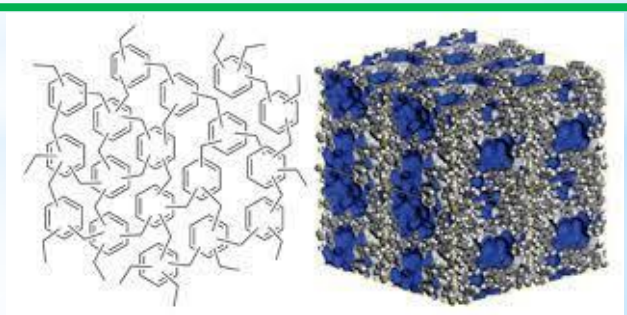
Enzyme Immobilization

Supporting on magnetic nanoparticles (MNPs), because of:

- large specific surfaces
- facilitated separation by external magnetic field
- the surface of NPs can be functionalized with several functional groups to build different catalysts
- cheap
- non-toxic
- biocompatible

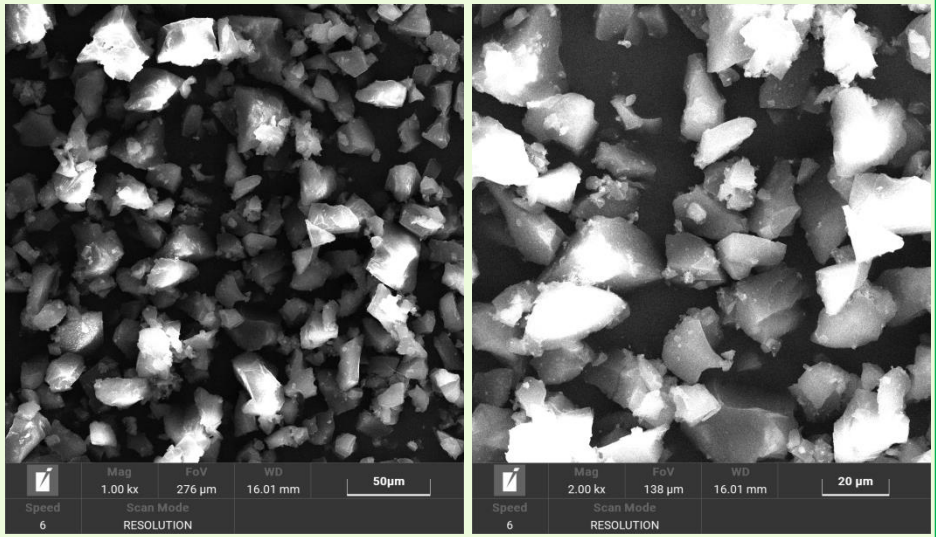


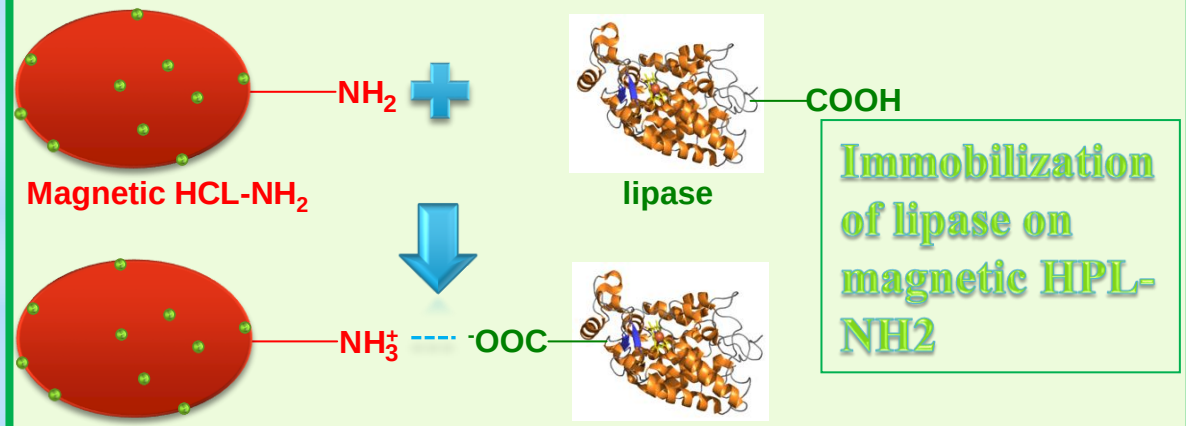
Hyper-cross linked (HCL) polymers are a new generation of highly porous polymers, possess high micropore contents and correspondingly high specific surface areas, suggesting their great application potential in sorption processes.



*Experiment results

SEM IMAGE OF MAGNETIC HPL-NH_2

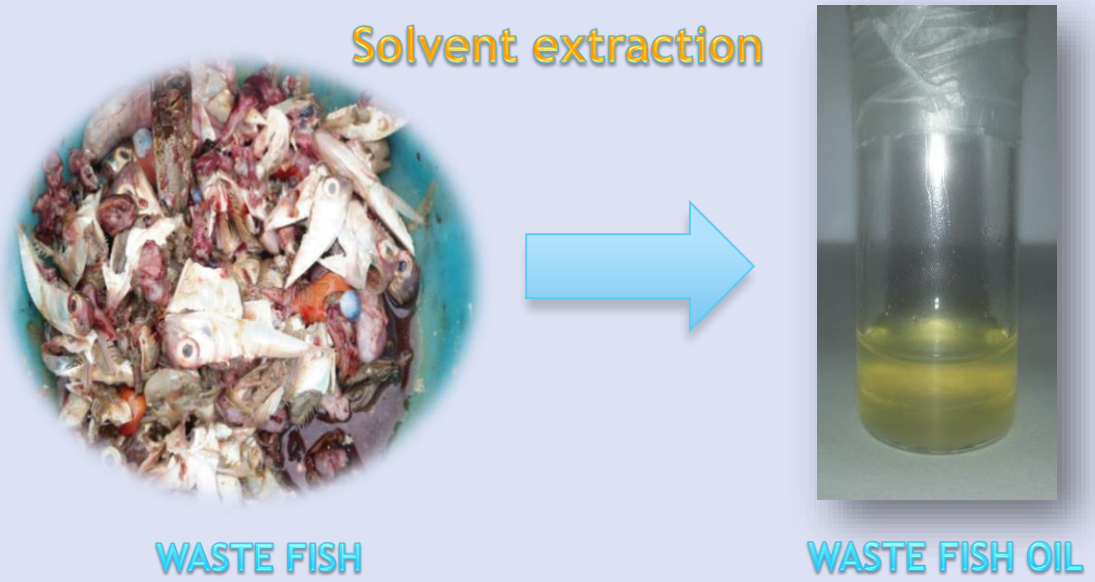




EXTRACTION OF WASTE FISH OIL.

Property	Value SEO
Acid value (mgKOH/g)	4.15±0.29
Free fatty acid content (%)	2.08±0.16
Moisture (%)	0.08±0.06
Iodine Value (gI_2/100g oil)	125.5±3.71

All values are expressed as mean±standard deviation of three replicates SEO= solvent extracted oil.



*Experiment results

Hydrolysis

Magnetic-HCL-lipase

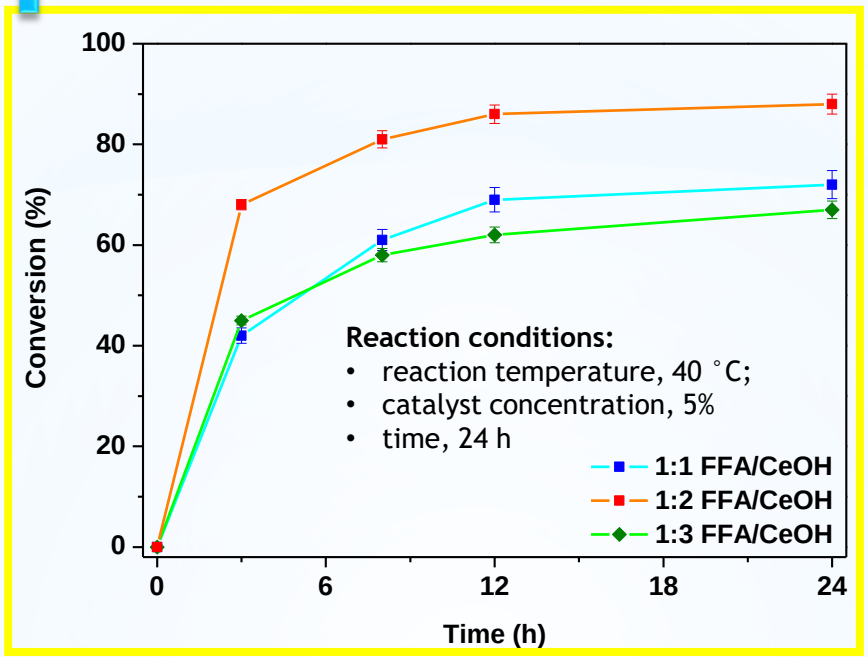
Fatty Acid + Glycerol

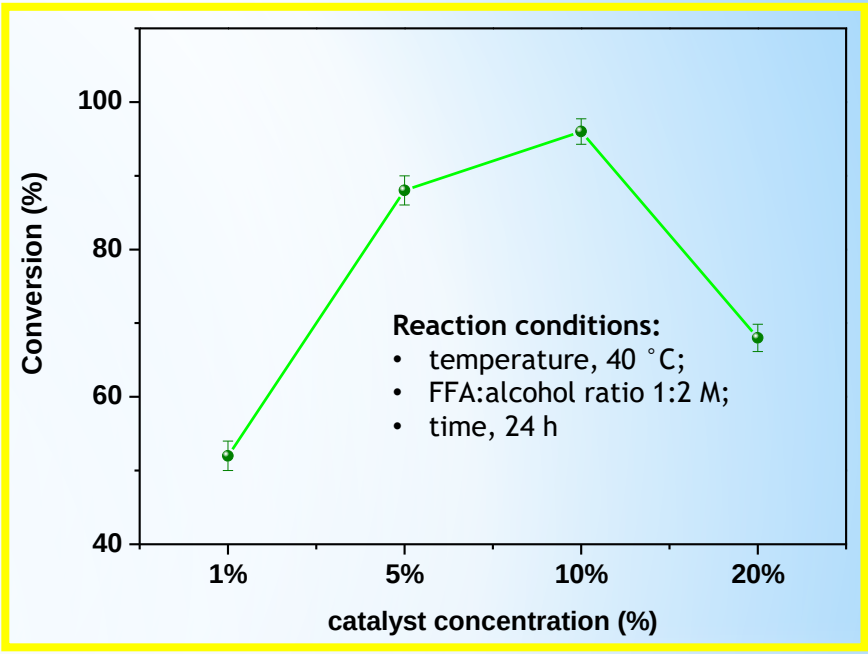
Esterification

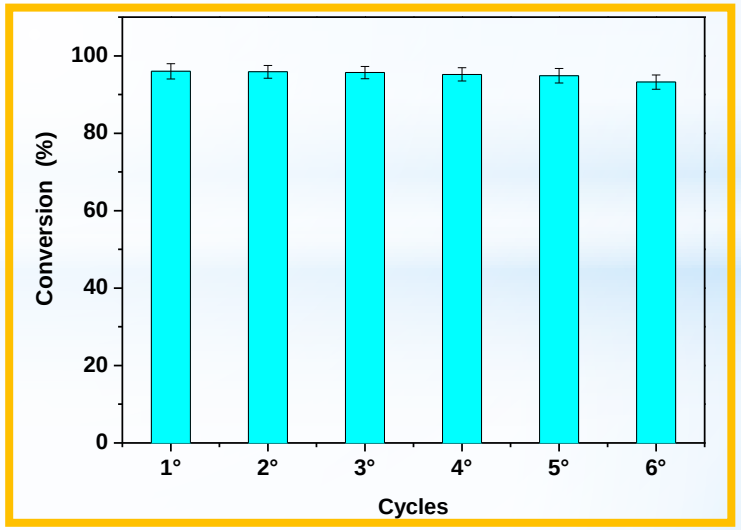
Magnetic-HCL-lipase

Cetyl Alcohol

Wax Ester + H_2O







Reaction conditions:
- temperature, 40 °C;
- catalyst concentration, 10%
- FFA:alcohol ratio 1:2 M;
- time, 24 h

*Conclusion

- A new nano-support was successfully synthesized for lipase immobilization
- Lipase was anchored through NH_2 groups of the support, hydrogen bonds, electrostatic interaction, and physical adsorption can be not excluded, too
- Waste fish oil was solvent extracted
- A very remarkable result, wax esters production with a conversion up to 96 %, which stays constant for 6 cycles, was obtained by using lipase simple anchored on a cheap support.

Magnetic HCL-NH_2-lipase catalyst showed both activity and magnetization stability, and overall promising catalytic properties for wax esters synthesis.

THANK YOU FOR THE ATTENTION