Valorization of Waste Cooking Oils through Conversion Processes Catalyzed by Choline Hydroxide

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BACKGROUND

❖ Biodiesel

- Biodiesel can be defined as mono-alkyl esters of long-chain fatty acids produced from vegetable or animal oils and alcohol with or without a catalyst. It can be produced by esterification of fatty acids or transesterification of triglycerides with short chain alcohols, such as methanol and ethanol. Methanol is used mainly due to its lower cost compared with other alcohols, so biodiesel most commonly refers to fatty acid methyl esters (FAMEs).

❖ Ionic Liquids

- Main properties:
  - Low-melting organic salts that are liquid at room temperature
  - Non-volatile
  - Thermally stable
  - Their solvation properties vary with changes in the cation and anion.

- They represent one of the most important class of green solvents and have attracted much interest over the past three decades in chemical community owing to their unique physical and chemical properties.

❖ Waste Cooking Oils (WCO)

- The processing of waste facilitates a consistent supply of raw material compared to competition with edible raw materials, which are more valuable as part of consumable food items. Thus, the use of WCO as a low-grade raw material for the synthesis of renewable fuel ensures price stability and process sustainability.

❖ Catalyst

- Catalysts are used to increase reaction rate and efficiency of methyl ester production.
- They can be homogeneous basic catalysts, homogeneous acid catalysts, enzymatic catalysts or ionic liquids.

Figure 1 shows the structure of choline hydroxide (ChOH), used to catalyse the production of biodiesel.

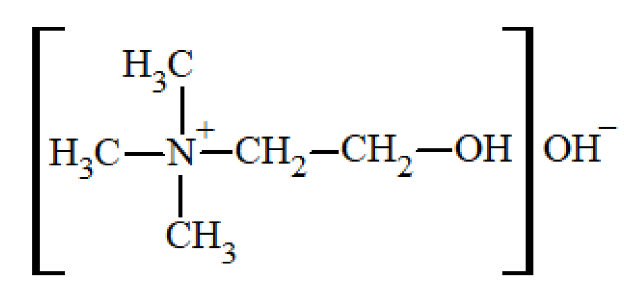
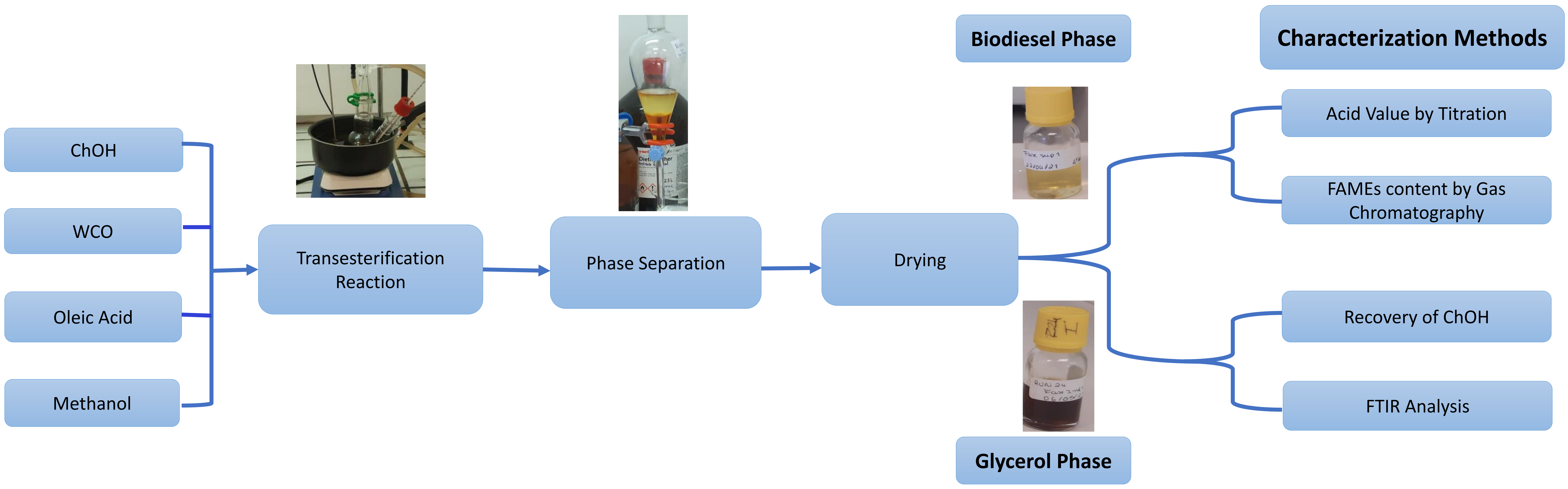


Figure 1. Structure of Choline Hydroxide.

METHODOLOGY



EXPERIMENTAL RESULTS

❖ Surface Response Methodology using Box-Behnken Design

- Factorial design with four factors at three levels.
- Study of two responses: % FAME Content of the biodiesel produced and % Acidity.
- Responses measured by gas chromatography and acid-base volumetric analysis.

Fixed operational parameters: Reaction Time – 30 min

Table 1. Reaction conditions and responses of biodiesel production.

Sample	Temperature (°C)	Molar Ratio WCO/Methanol	Catalyst Dosage (wt%)	Incorporation of Oleic Acid (wt%)	Conversion (% FAME)	Conversion (% Acidity)
1	65	1:15	4	1	92.97	0.46
2	60	1:15	4	0	80.98	1.19
3	60	1:15	4	2	78.35	1.35
4	60	1:10	6	2	75.56	0.67

Table 2. Esters characterization of biodiesel samples from GC-FID analysis.

Compound Name	Structure
Palmitic acid methyl ester	C16:0
Heptadecanoic acid methyl ester	C17:0
Stearic acid methyl ester	C18:0
Oleic acid methyl ester, Elaidic acid methyl ester	C18:1(c+t)
Linoleic acid methyl ester, Linolelaidic acid methyl ester	C18:2(c+t)
Behenic acid methyl ester	C22:0
Erucic acid methyl ester	C22:1

CONCLUSIONS

Choline hydroxide proved to be an efficient catalyst for the catalysis of triacylglycerol to produce biodiesel, since a conversion of 92.97% in FAME content was obtained in just 30 minutes of reaction.

Table 1 shows that sample 1 presents the best reaction conditions to produce biodiesel: temperature of 65 °C, WCO/methanol 1:15 molar ratio, 4% catalyst dosage, and 1% of oleic acid incorporation, obtaining a FAMEs conversion of 92.97% and acidity conversion of 0.46%.

The results presented are partial, they do not correspond to the totality of the results predicted with Box-Behnken Design.

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