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EDITED BY
Ankures Bhattacharya
West Bengal University of Animal and Fishery Sciences

REVIEWED BY
Dr. Supratim Chowdhury
West Bengal University of Animal and Fishery Sciences

Dr. Jitesh B. Solanki College of Fisheries Science, Kamdhenu University.

*CORRESPONDENCE
Ratul Brahma
Ratulbrahma3@gmail.com

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A Mini-review on Biodiesel Production from Fish Waste

Ratul Brahma[1], Prasanta Murmu[1] and Swarnadyuti Nath[1]

[1]Department of Fish processing Technology, Faculty of Fishery Sciences, West Bengal University of Animal and Fishery Sciences, Kolkata, Pin-700094

Fish processing plants generate billions of tonnes of fish waste each year. When these wastes are discharged into the environment, they produce pollutants that harm the soil. An alternate answer to the problem is to convert them into biofuel, pharmaceutical components, fertilizer, and feed. Biofuel is a popular notion that may be used as an alternative to conventional fuels. Biofuels are pollution-free and hence superior to conventional fuels. Organic waste, seaweed, and microalgae are used to make biofuels. The work done on fish wastes for biodiesel generation is motivated mostly by their benign and biodegradable characteristics. When compared to normal fuel or diesel, biodiesel emits less air pollutants, CO2, hydrocarbons, and other particles. The conversion process comprises the extraction of fish oil from fishing industry trash. The oil has been cleansed and refined. Transesterification and anaerobic digestion, with the inclusion of a catalyst, yield biodiesel and bio-gas. Various studies, including Fourier transform nuclear magnetic resonance (FT-NMR), gas chromatography mass spectrometry (GCMS), and proton nuclear magnetic resonance (H-NMR) examination, as well as best management practices (BMP) test, reveal that biofuels are efficiently converted and used.

Keywords
Biodiesel, Fatty acid methyl ester, Transesterification, Chromatography, Spectrometry

Introduction

Biodiesel is a diesel fuel substitute made from a variety of fatty-acid-methyl-ester-producing processed vegetable oils, animal fats, or waste frying oil (Dorado *et al*., 2003). It is defined as a substitute fuel that improves environmental circumstances while also contributing to energy sustainability (Edlund *et al*., 2002). The usage of blends containing 2-30% fossil diesel fuel necessitates no engine modifications. Minor changes may be required in some circumstances for the usage of 100% pure biodiesel (Williams, 2002). The body of work produced mostly in scientific journals about diesel engine emissions while utilizing biodiesel fuels as a substitute to conventional diesel fuels was collected and analyzed. It is highlighted that the intriguing potential of biofuels to reduce chemical emissions. However, the effect of biodiesel differs for each pollutant species and is dependent on the type of engine, engine speed and load circumstances, ambient conditions, and the origin and quality of the biodiesel. It is compared the exhaust emissions produced by several types of FAME (fatty acid methyl esters) created from used cooking oils and animal fats (Lapuerta *et al*., 2008). The number of wasted pieces of marine fish in the manufacturing procedures of various fishery products made from fish is around 25% of total fishing production (Lin and Li, 2009). Mackerel fish oil can be extracted from wastewater from mackerel processing factories, transformed into mackerel biodiesel. The transformed mackerel biodiesel can be then tested for emissions on a diesel engine that ran on pure mackerel biodiesel, premium diesel, and a blend of the two. CO, CO2, NO, NOx, SO2, and particulate matter (PM) production were studied (Wu *et al*., 2014).

Materials for Production of Biodiesel

The chemicals were used without any prior purification: Sodium hydroxide (97%), potassium hydroxide (85–100%), diethyl ether (99.5%) and methyl hepta-decanoate (99%), methanol (99.9%), ethanol (99.9%), Hexane (95%), and cyclohexane (99.9%), and sulfuric acid (96%) (Kara *et al*., 2017)

Methods of Producing Biodiesel

Pre-treatment

Initially the oil can be vacuum-filtered to eliminate any solid contaminants and a fraction of the water. It can be then degummed using phosphoric acid and water to eliminate polar components like phospholipids, lecithin, colors, and heavy metals. The neutralization should be accomplished by using potassium hydroxide to eliminate free fatty acids as soap. The residual contaminants and colorant were subsequently removed using silica gel column chromatography employing (90% cyclohexane and 10% ethyl acetate) as the solvent. It additionally dried easily by heating it at 105˚ C for 15 minutes. This period can be calculated by observing the weight decrease while heating. Finally, deodorization was accomplished by heating under hoover. The strength of the aroma comes next by a simple flair, and it was measured into a Pyrex tube before being hoover heated at 90˚ Celsius (Kara *et al*., 2017).

Esterification-Transesterification process

Esterification-transesterification was used to produce biodiesel from WFO in two stages. To begin, the esterification reaction was carried out in a three-neck round bottom flask (Ace Glass Inc.) fitted with a thermometer for temperature measurement. A water-cooled condenser was attached to another neck on top of the reactor to limit methanol evaporative loss. The third neck is utilized for chemical input and sample collection. A hotplate was used to heat the reactor. Before adding the combination of methanol and catalyst to every esterification run, an amount of acidic waste vegetable oil was brought to the reactor and heated to the proper temperature. A sample aliquot was taken from the flask that was used for titration. Vacuum distillation was used to extract the unreacted alcohol and water using a

BUCHI Rotavap R-114 fitted with a BUCHI Water-bath B-48 (Kara *et al*., 2017).

Fig 1. Waste fish oil before and after purification (Kara *et al*., 2017)

The transesterification process of esterified WFO can be carried out as follows: The oil was warmed at 60˚ C and stirred before being added to a solution of KOH in methanol at various temperatures. The resultant liquid was placed in a separating funnel for 8 hours to separate glycerol from biodiesel. Diluted phosphoric acid solution (4% v/v) and water steam bubbling to purify recovered methyl ester phase. Before analysis, the resulting fluid was dried at 80˚ C. The reactions and cleanings should be carried out in a methodical fashion (Kara *et al*., 2017).

Properties of WFO (Waste Fish Oil)

The oil quantity of fatty acids in waste fish oil can be quantified by chromatographic analysis. The WFO had a high acidity index. The fatty acid quantified in the oil in 28%. It can be suggested that the esterification procedure for producing biofuel from this raw material may be satisfactory. Regarding the physical properties of the WFO, the lower viscosity value of WFO indicates that the fuel's fluidity is enhanced with regard to other raw materials, which may be advantageous when performing retreatment reactions to reduce the FFA level (Costa *et al*.,2013).

Biodiesel`s Characteristics

1HNMR spectroscopy helps to interpret the biochemical properties of the WFO biodiesel. The production of methyl ester (-CO_2CH_3) can be indicated by the prominent singlet. The decrease of the signals might potentially be attributed to the removal of protons connected to the glycerol component of mono-, di-, or triacylglycerols. (Ouanji *et al*., 2016). As reported the 13C-NMR spectrum of waste fish oil biodiesel with Deuterated chloroform ($CDCl_3$) as a solvent had displayed the typical peaks of ester carbonyl(-COO-) and C-O. The degree of unsaturation in methyl esters was revealed by other peaks. Peaks at 14 ppm were caused by terminal carbons of methyl groups, and signals at 27-34 ppm are caused by methylene carbons in fatty acid methyl esters (FAMEs) (Tariq *et al*., 2011). The chemical profile of the synthesized biodiesel can be investigated using GC-MS analysis. Each peak represents the WFO biodiesel's fatty acid methyl ester concentration. GC-MS study of fatty acid methyl esters in WFO biodiesel revealed the existence of palmitic acid methyl ester (C16:0), oleic acid methyl ester (C18:1), linoleic acid methyl ester (C18:2), and linolenic acid methyl ester (C18:3) (Kara *et al*., 2017).

Evaluation of Cost

The expenses of waste fish oil biodiesel were compared to those of salmon oil and soybean oil biodiesel in an economic analysis. Assume the only difference between discarded salmon, and soybean oil biodiesel plant hardware is the cost of raw materials utilized in biodiesel manufacturing. It is simple to understand why waste fish oil biodiesel mix makes good economic sense at a cost of 0.69 US $/l compared to 1.065, 0.527, and 0.91 US $/l for salmon biodiesel, soybean biodiesel, and diesel fuel, respectively (El-Mashad *et al*., 2008).

Conclusion

Because of the considerable acid value of fish oil, alkaline catalyzed transesterification was discovered to be ineffective for producing biodiesel from waste fish oil. Presently it is rumoured that waste fish oil with a significant free fatty acid content may be used to make biodiesel. The established procedure included a quick purification approach as well as an acid esterification pretreatment followed by basic transesterification.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Conflict of interest

The authors declare that the manuscript was formulated in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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