EXTRACTION OF RESIDUAL OIL FROM PALM OIL MILL EFFLUENT (POME)

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Introduction

Palm oil has been widely used across the continent for several decades for the production of household products as well as biofuels (Kaniapan et al., 2021). In Malaysia, the palm fruit species harvested is important global oil crop *Elaeis guineensis* which gives a high yield (Murphy et al., 2021). The palm oil industry undeniably helps to increase the economy sector of Malaysia but at the same time, the processing of palm oil brings a lot of adverse effects to the environment such as air pollution, water pollution and soil pollution. The release of huge amount of palm oil mill effluent (POME) into the streams has gain major concern from many parties as this activity is known to be one of the main reasons for the destruction of aquatic ecosystem. POME is not toxic but it is rich in organic compound which will greatly deplete the dissolved oxygen content in the water source, harming the aquatic organisms. The high composition of residual oil in POME is not favourable due to its low water solubility and not readily biodegradabl. Thus several treatment methods of POME have been introduced to overcome this problem and in this study, extraction of residual oil in POME before released to streams is one of the promising approach.

Methodology

Extraction using *n*-hexane and methanol

500 ml of POME obtained from Felcra Jaya Palm Oil Mill in Kota Samarahan, Sarawak was transfered in a beaker and subjected to drying at temperature higher than 110ºC in the oven until solid deposits were formed. The solid deposits were then scraped off using spatula, wrapped in filter paper and inserted into a thimble. The thimble was transferred into Soxhlet apparatus and extraction process was carried out by using methanol as the solvent for 8 hours. The methanol in the raffinate was then recovered using rotary evaporator. The amount of extracted oil was determined by comparing the weight of empty flask with the weight of flask after extraction. The process was then repeated by using *n*-hexane.

Brine Shrimp Toxicity Test

Toxicity test is conducted to determine whether the POME has toxic effect on the organisms. The test was carried out by using the method proposed by Mclaughlin et al., (1998) which uses *Artemia salina* (brine shrimps) as the bioassay to determine the survival rate of the species in respective solutions. The brine shrimps were used for the test only after 48 hours. Two mililiter (2 ml) of POME was dissolved in 2 ml dimethyl sulfoxide (DMSO) and 5 µl, 50 µl and 500 µl of each diluted solution were placed in three separate test tubes and evaporated to dryness. Then, 5.0 ml of seawater was added into each test tubes and the final concentration would be 1.0 µg/ml, 10.0 µg/ml and 100 µg/ml respectively. Another test tube which contains only sea water was used as the control. Exactly 2.0 ml of each solution was transferred into NUNC multidish and 10 larvae of *Artemia salina* were added. The larvae were left in contact with the solution for 24 hours and the number of larvae survived was counted.

Fourier Transform Infrared (FTIR) Characterization

The dried extracted residual oil samples were subjected to FTIR spectroscopy characterization and recorded as function of wave number via transmittance mode.

Results & Discussion

Extraction using n-hexane and methanol

The residual oil in POME was extracted via solvent extraction method by using *n*-hexane and methanol as the solvent. The average amount of oil extracted by *n*-hexane and methanol were 0.070 g and 0.050 g respectively. The difference in the amount of oil extracted was influenced by the polarity nature of both solvents. *N*-hexane is non-polar while methanol is polar. Polar solvent like methanol was ineffective in extracting oil from POME because it dissolves in water (in this example, wastewater), which is difficult to extract. Hence, non-polar solvent *n*-hexane is more extracted more residual oil from POME, as they are capable of dissolving into oil (Nuryanti et al., 2019).

Brine shrimp *Artemia salina* toxicity test

This test was conducted to evaluate the aquatic toxicity characteristic of the palm oil mill effluent (POME). The number of *Artemia salina* survived after 24 hours as well as percentage of mortality was shown in Table 1. High mortality rate of more than 50 % were observed when the shrimps were exposed to POME and maximum mortality occurred in 100 ppm of POME. This was most likely caused by the lack of dissolved oxygen in POME as the oil in the effluent may float on the water surface and form wide-spread film, causing declination of the amount of atmospheric oxygen dissolving into the water (Azad et al., 2019).

Table 1: The number of *Artemia salina* survived and mortality rate at different concentrations of P

Sample	Concentration (ppm)	Number of surviving *Artemia salina* after 24 hours	Mortality (%)
POME	Control	10	0
	1	3	70
	10	1	90
	100	0	100

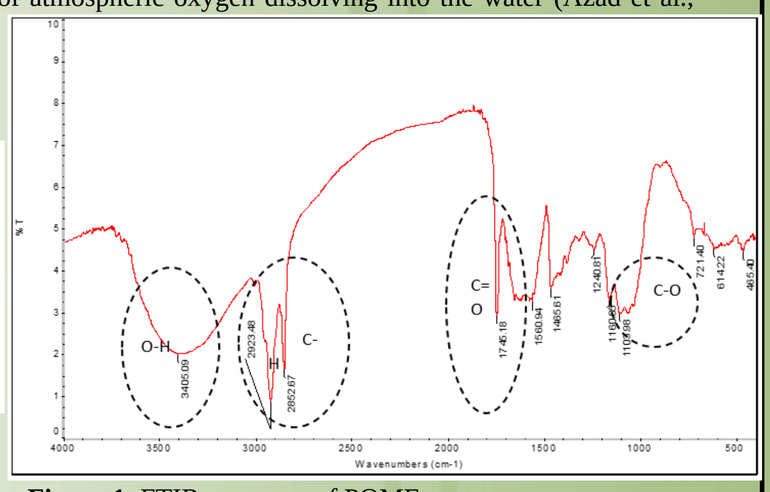

Figure 1: FTIR spectrum of POME

Fourier Transform Infrared (FTIR) Characterization

Figure 1 shows the IR spectrum of POME. A peak at 3405 cm^{-1} can be seen which indicates the carboxylic acid O-H stretch and peaks at 2923 cm^{-1} and 2852 cm^{-1} indicates C-H stretch. Other peaks were observed at 1745 cm^{-1} and 1103 cm^{-1} which indicated C=O stretch and C-O stretch respectively. The functional groups observed are similar to the functional groups in unsaturated fatty acids such as linoleic acid (Bahadi et al., 2016). According to A Aziz et al. (2020) , POME is composed of dissolved substances such as lipids, carbohydrate and protein.

Conclusion

POME residual oil was successfully extracted using soxhlet extraction technique using two different solvents; methanol and *n*-hexane in which *n*-hexane is better extraction solvent. For qualitative analysis of POME, peaks at 3405 cm^{-1} indicate carboxylic acid O-H stretch, while peaks at 2923 cm^{-1} and 2852 cm^{-1} corresponds to C-H stretch. Other peaks at 1745 cm^{-1} and 1103 cm^{-1} corresponds to C=O stretch and C-O stretch, respectively which is similar to those functional groups of unsaturated fatty acids in palm oil. Brine shrimp mortality test results show a 100% mortality rate when the shrimps were exposed to POME, indicating that POME is toxic to aquatic organisms. Thus, it is important to remove the residual oil in POME before it can be released safely as wastewater. In addition the extracted residual oil is a promising material to be utilized as renewable energy.

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