Effects of Solvents Extraction To The Fish Oil From Fish Waste

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ABSTRACT: Fish waste was investigated for its oil production and fatty acid methyl ester (FAME) content. Four types of solvent with different polarity were used to investigate the effectiveness of the extraction process using a simpler modified soxhlet extraction. Ethanol, which yielded 49.0%, was determined to be the best solvent for fish oil extraction, followed by ethanol:heptane (1:1) > methanol:heptane (1:1) > methanol. A substantial yield of oleic acid (C18:1) was found in the oil extract composition, ranging from 42% to 66%, followed by palmitic acid (C16:0) > palmitoleic acid (C16:1) > stearic acid follow (C18:0). These findings showed that ethanol can extract a better yield of oil with high amount of oleic acid content.

Keywords: *Fish waste; Oleic acid; Soxhlet*

1. INTRODUCTION

Fish oil generated from fish waste is believed to have a variety of possible uses, including the production of polyunsaturated fatty acids (PUFA) and biodiesel [1]. A transesterification phase as well as a conversion to fatty acid methyl ester are included in the process of converting fish waste into biodiesel (FAME) [2].

To extract the oil from the fish waste, various extraction processes were chosen [3]–[5]. Soxhlet extraction is the most commonly used technique in extracting fish oil because it is the simplest, cost-effective, and most acceptable method for lipid determination [6]. However, there are several disadvantages, such as the flammability of the solvents employed and the disposal of toxic solvent waste.

The purpose of this study was to quantify and investigate the effect of solvent systems to the oil output and FAME content of the fish waste.

2. METHODOLOGY

2.1 *Preparation of fish wastes and solvent extraction*

The waste fish from the Kuantan, Malaysia's Jaya Gading fish market. The waste from the fish was washed, dried, and pulverised into a powder.

The condenser was coupled to powdered fish waste in a flat bottom flask with a solvent ratio of 6/100 (w/v). Four different solvent systems were used in separate experiments: ethanol, methanol, ethanol:heptane (1:1), and methanol:heptane (1:1). The flask was heated in a beaker filled with water. For 4 hours, the temperature was set to 60°C and the speed was set to 500 rpm.

The extracted material was then centrifuged for 5 minutes at 3000 rpm. The oil was then transferred to a vial and heated at 100°C for 24 hours.

2.2 *Oil yield % determination*

The oil yield percentage was calculated based on Adejumo et al. [7]. The percentage of oil yield (%) is denoted by X.

$$X = \frac{\text{Weight of oil extracted (g)}}{\text{Weight of fish waste powder before extracted (g)}} \times 100\% \tag{1}$$

2.3 *Fatty Acid Methyl Ester (FAME) analysis*

The FAME is formed from the fatty acid in the oil using the Gaikwad et al. [8] method.

3. RESULTS AND DISCUSSION

The effects of several solvents on fish waste extraction were investigated, particularly the oil yield and fatty acid methyl esters composition (FAMEs). Figure 1 shows how different polar and non-polar solvents were tested for their capacity to extract oil. The polarity of the solvent has an effect on the oil yield, as shown in the graph. The yield from ethanol extraction was greater. The oil yields obtained with ethanol were 49.0% with ethanol, 28.1%, 19.0%, and 11.8%, with ethanol:heptane, methanol:heptane, and methanol, respectively. The oil yield achieved in this study was comparable to that reported in previous research by Mudalip et al. [9] and Ferdosh et al. [10].

This phenomenon could be due to the understanding that fish oil contains both nonpolar and less nonpolar structures, which referring to the ethyl ester and triglycerides, respectively. The solvents polarity used in the study is specified based on the dielectric constant values. At 20-25°C, the dielectric constant values for ethanol, methanol and heptane are 24.55, 32.70 and 1.92, respectively. The higher the dielectric constant, the higher the solvent polarity. With a suitable polarity of solvent, the oil extraction is maximized.

The oil compositions also varied according to the solvent type, as shown in Figure 2. The extracted fish oil contained five FAMEs compounds: oleic acid (C18:1), palmitic acid (C16:0), palmitoleic acid (C16:1), stearic acid (C18:0), and linoleic acid (C18:2). Palmitic and stearic acids are saturated fatty acids (SFAs), while palmitoleic and oleic acids are monounsaturated fatty acids (MUFAs), and linoleic acid is a polyunsaturated fatty acid (PUFAs). The fatty acid of the fish waste revealed that the dominant fatty acid at all solvent types is oleic acid (C18:1), with a yield ranging from 42% to 66%. The yields of palmitic, palmitoleic, and stearic acids vary depending on the solvent type, ranging from 5% to 26%. While linoleic acid is detected in the smallest amount in all solvents, it does not exceed a 3% yield.

Fatty acids with a high oleic acid content (C18:1) have been reported to have good biodiesel properties due to increased oxidative stability for longer storage, better cold flow properties, cetane number, specific gravity, and viscosity [11], [12].

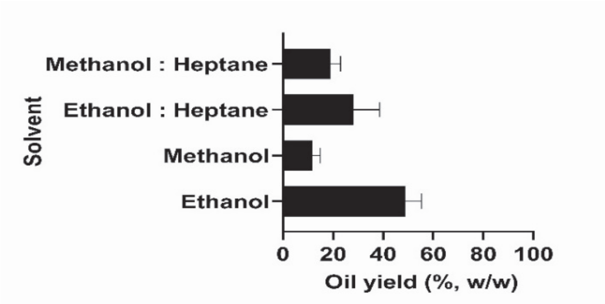

Figure 1: Effect of solvents to the fish oil yield.

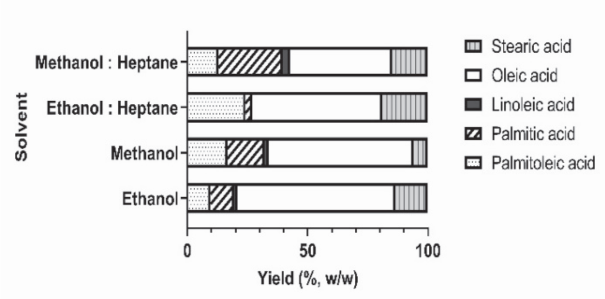

Figure 2: Effect of solvent to the FAME yield.

4. CONCLUSION

Fish waste was successfully extracted through soxhlet extraction using a variety of solvents with different polarities. Ethanol has been shown to be the best solvent, yielding almost three times more oil than the other solvents. Oleic acid was the most common fatty acid found in fish waste (C18:1), which implying that there is a high potential for cost-effective biofuel production.

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