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EPOXIDATION OF WASTE COOKING OIL-BASED PALM OIL VIA PRILESCHAJEW REACTION

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ABSTRACT

In this study, waste cooking oil-based palm oil were choosing as feedstock for epoxidation reaction. At present, there are limited studies on the production of epoxidised waste cooking oil-based palm oil to obtain high relative conversion to oxirane. Epoxides are valuable substances with a wide variety of applications such as plasticizers, adhesives, and lubricants. The epoxidation process of waste cooking oil-based palm oil was carried out using in situ generated performic acid or known as Prileschajew reaction. The first objective was achieved by obtaining the stirring speed at 300 rpm and sulfuric acid as catalyst. Then, the stirring speed and catalyst were used constantly throughout the epoxidation experiments for optimisation. Moving to second objective, Taguchi method of optimisation and analysis of variance (ANOVA) were used to conduct series of experiments around the optimum conditions or parameters. Hence, it was found that the best combination to produce the highest %RCO which was 70.6% is a hydrogen peroxide molar ratio of 2:1, a temperature of 55°C, formic acid molar ratio of 2:1 and catalyst loading of 0.5g. Finally, for third objective, the rate constant and activation energy for epoxidation of waste cooking oil-based palm oil at optimum condition were found at 0.0221 min^{-1} and 50.55 kJ/mol, respectively. Overall, epoxidised waste cooking oil-based palm oil was successfully produced by using optimum process parameters of epoxidation.

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CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

Vegetable oil has been in high demand recently, especially in the manufacturing sector. The oil is a raw material that helps to reduce pollution in the atmosphere. Palm oil is one of the vegetable oils in the industry, and it is commonly used in the development of polymeric materials. The market for vegetable oil has increased compared to petroleum-based polymers [1]. This is because vegetable oil is both environmentally friendly and inexpensive. On the other hand, petroleum has caused environmental degradation and is becoming more expensive [2]. As a result, vegetable oil becomes a viable option for epoxide development. This study chooses waste cooking oil-based palm oil (WCO-PO) as it primarily comprises saturated and unsaturated fatty acids, with unsaturated bonds containing double carbon bonds [3]. WCO-PO contains unsaturated double carbon bonds of oleic and linoleic acids; thus, it can be modified to produce epoxide products [4]. One of the properties of oleic and linoleic acids is that they have the highest thermal stability and are the preferred components in vegetable oils for producing epoxides [5,6].

Epoxide groups are formed when double bonds are converted by a chemical reaction [7]. Soybean oil, sunflower oil, and palm oil are among the sources that can be used to produce epoxidised vegetable oil. This type of oil can be produced using four different techniques or processes: (i) epoxidation with peracids, such as peracetic acid or perbenzoic acid, in the presence of an acid catalyst; (ii) epoxidation with organic and inorganic peroxides, including transition metal catalysts; (iii) epoxidation with halohydrins using hypohalous acids and their salts; and (iv) epoxidation with molecular oxygen [8,9,10]. This research chooses epoxidation by peracid mechanism, also known as the Prileschajew reaction, in which epoxidation can be achieved by reacting vegetable oil's double bond with peroxyacid generated *in situ* from concentrated hydrogen peroxide (H_2O_2) and formic acid or acetic acid in the presence of a catalyst [11]. The Prileschajew reaction is chosen because formic and acetic acids are readily available at a relatively low price in liquid form at room temperature. There are numerous functions and applications of epoxides, including (i) generation of