UNIVERSITI TEKNOLOGI MARA

OPTIMIZATION OF PALM KERNEL OIL BASED OLEIC ACID EPOXIDATION USING TAGUCHI'S METHOD

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ABSTRACT

Studies pertaining to epoxidation of fatty acids have garnered much interest in recent years due to the rising demand for eco-friendly epoxides derived from vegetable oils. Epoxide is an important chemical precursor for the production of alcohols, glycols and polymers like polyesters and epoxy resin. Commercial epoxides available in the market are mainly petroleum and animal based which are non-environmental friendly and often non-halal. Oleic acid (C18:1) derived from palm kernel oil contains the unsaturation double bond (C=C) in its long alkyl chain makes it an attractive fatty acid for the production of eco-friendly epoxide. The epoxidation of oleic acid was carried out by using *in situ* generated performic acid (HCOOOH) to produce epoxidized oleic acid. Performic acid was formed by mixing formic acid (as oxygen carrier) and hydrogen peroxide (as oxygen donor). The epoxidation reactions were conducted by varying the formic acid to oleic acid mole ratio, hydrogen peroxide to oleic acid mole ratio, reaction temperature, stirring speed and finally type of catalyst. The signal-to-noise (S/N) ratio and the analysis of variance (ANOVA) were employed in the determination of optimal epoxidation reaction conditions based on Taguchi optimization method. The results indicated that optimum conditions occurred at moderate temperature of 55°C, formic acid to oleic acid mole ratio of 1:1, hydrogen peroxide to oleic acid mole ratio of 1:1. Sulfuric acid was found to be the most efficient catalyst. It was found that a maximum relative conversion to oxirane (RCO) achieved was 87.61 % at optimal condition. The rate constant for epoxidation of oleic acid was found to be in the order of 4.683×10^{-4} mol^{-1} s^{-1} and activation energy is 3.76 $kcal.mol^{-1}$. In addition, thermodynamic parameters such as enthalpy, entropy and free energy of activation of 3.11 $kcal.mol^{-1}$, -62.76 $cal.mol^{-1}$ K^{-1} and 23.69 $kcal.mol^{-1}$ respectively. The epoxide ring is very reactive, especially in the presence of acidic condition making the epoxide a suitable intermediate for synthesis of other chemicals. The most likely side reaction that occurred in the *in situ* epoxidation is the reaction of oxirane ring with formic acid which led to formation of diol and *a*-glycol as side products. Oxirane cleavage of the epoxide was studied and suggests first order in oxirane concentration and second order with respect to formic acid.

TABLE OF CONTENTS