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PREFACE

10th Virtual Science, Invention, Innovation & Conference 2021 (SIIC 2021) is organised by Faculty of Chemical Engineering that serves as a platform for final year students from Faculty of Chemical Engineering, UiTM Cawangan Pulau Pinang to highlight idea, innovation, invention and design in their respective field. The event was formerly known as Science, Invention, Innovation & Conference. It has garnered multiple successes following the preceding events from 2016 to 2020. SIIC 2021 showcases products commercialization, ideas, inventions and designs that are highly innovative, competing against each other to be recognized as the best among the best. Adhering to the Industrial Revolution 4.0 movement, the competition seeks out outstanding products that are able to keep up with the rise of automation and artificial intelligent innovations – ideas that can change the way we live, work, and communicate for the better. It is also in line with the government's desire to encourage innovation activities in Malaysia.

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Congratulation

GOLD AWARD



SITI MARIAM WASLI

Supervisor: Dr Hamizura Hassan

PRODUCTION OF HIGH QUALITY BIO-OIL VIA
PYROLYSIS OF LIGNOCELLULOSIC BIOMASS: A
REVIEW ON ROLE OF PLASTIC AND CATALYST
TYPES



JENIFER DENNIS

Supervisor: Prof Madya Ir Dr Chang Siu Hua

MULTIELEMENT EXTRACTION FROM AQUEOUS
SOLUTIONS BY PALM KERNEL FATTY ACID
DISTILLATE



NURUL AIN GHAZALI

Supervisor: Ir Mohd Azahar Mohd Ariff

REACTOR: EFFECT OF DIFFERENT PRESSURE
AND TEMPERATURE ANALYSIS USING ANSYS





Congratulation

SILVER AWARD

MOHD QAMARUL
AKMAL MOHD ZAKI

Supervisor: Siti Khadijah Jamaluddin

UNSATURATION DEGREE OF DATED PALM
KERNEL OIL AND ITS POTENTIAL AS
PRECURSOR FOR EPOXIDATION

MUHAMMAD SYIMIR
AB HAMID

Supervisor: Mohd Haris Riszuan Ooi Abdullah

COMPARATIVE STUDY ON CALIXARENES IN
DRUG ENCAPSULATION AND DELIVERY

PASCAL PERRIN
ANAK JITES

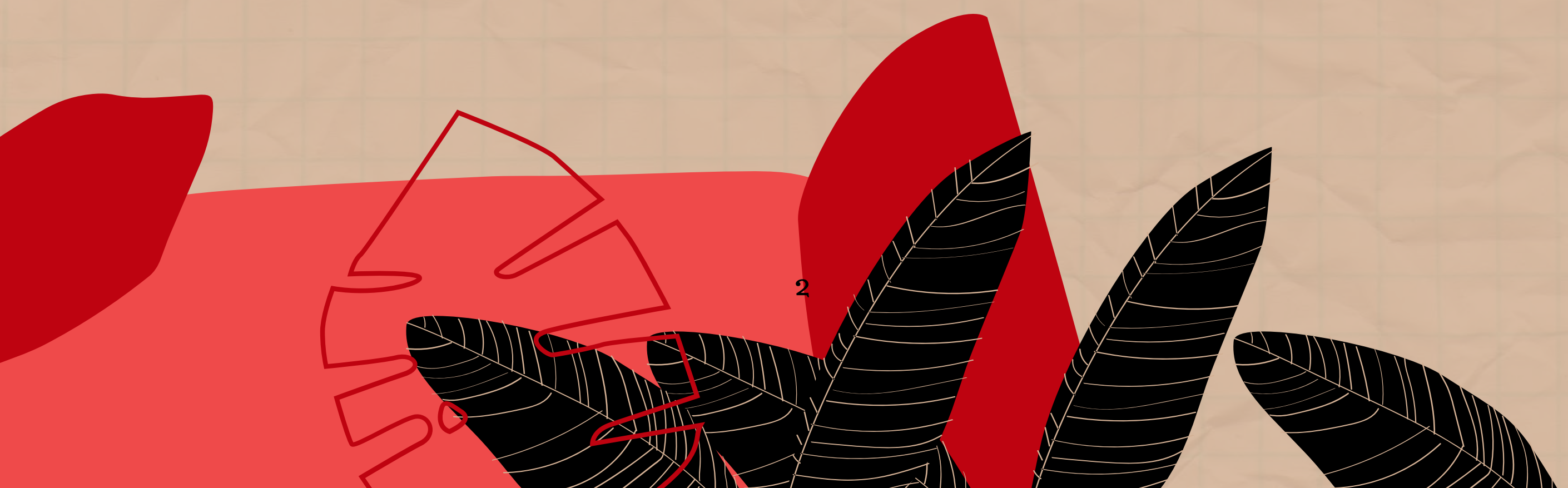
Supervisor: Mohd Jumain Jalil

PRODUCTION OF EPOXIDIZED PALM OIL
DERIVED OLEIC ACID BY USING PERACID
MECHANISM

NOR FAZLINA ABDUL
GHANI

Supervisor: Dr Nor Fariza Ismail

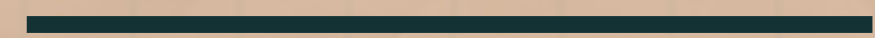
EXTRACTION OF HIBISCUS ROSA SINENSIS
LEAVES USING UNTRASONIC WATER BATH IN
DETERMINING THE PHENOLIC CONTENT.





Congratulation

BRONZE AWARD



FATIHA WAHIDA
MOHD NOR

Supervisor: Prof Madya Dr Hadi Zainal

A COMPARATIVE STUDY ON OPTIMIZATION OF
THE NANO MAGNETIC MATERIAL IN RECYCLE
FUEL OIL

KU MUHAMMAD
SYAMIL

Supervisor: Dr Nor Fariza Ismail

COMPARISON OF COFFEE WASTEWATER
TREATMENT TECHNOLOGIES

MUHAMMAD FAID
SHAHMI

Supervisor: Dr Siti Aminah Md Ali

A STUDY OF CO₂ METHANATION OVER NICKEL
BASED CATALYST - A REVIEW.

MUHAMMAD AMIR
SYAZWAN

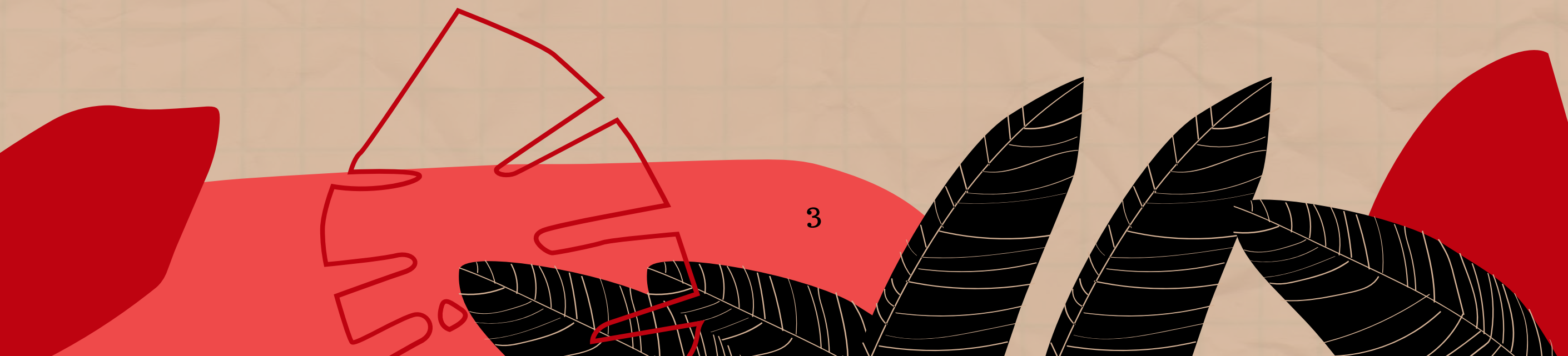
Supervisor: Mohd Jumain Jalil

PRODUCTION OF EPOXIDIZED PALM OIL -
DERIVED OLEIC ACID BY USING ACIDIC ION
EXCHANGE RESIN (AIER): EPOXIDATION
METHOD & KINETIC STUDY

SITI ATHIRAH RAMLI

Supervisor: Dr Wan Zuraida Wan Kamis

SYNTHESIS AND CHARACTERIZATION OF
MIXED OXIDES CATALYST TO PRODUCE FAME



SIIC01

A COMPARATIVE STUDY ON OPTIMIZATION OF THE NANO MAGNETIC MATERIAL IN RECYCLE FUEL OIL

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Abstract:

Quality of recycle fuel oil could be affected by the degradation of storage stability and colour. In this review paper briefly cover the comparison of uses of magnetic particles, Fe_3O_4 , SiO_2 , and Al_2O_3 which is used to determine the fuel stability such as sulphur content, effect of colour degradation and pH analysis by using FTIR, Uv-Vis Spectroscopy and GC-MS. Gas chromatography-mass spectrometry (GC-MS) were used to identify the chemical constituents in the prepared recycle fuel oils (waste lubricants oil). ASTM D1500 were used in order to determine the viscosity of a colour from waste lubricants oil and the UV-Vis spectroscopy with 1 cm of optical glass is used for measurement [16]. CaO nano catalyst supported by Fe_3O_4 magnetic particles were prepared by dissolving the calcium nitrate in deionized water with appropriate amount and 3.5g of Fe_3O_4 is added into the solution prepared. Then the suspension will be observed until a pH of 12 were appeared. Then, the samples colour was compared with the standard glass colour according to ASTM D1500. Fifteen papers are used as the main references to identify the optimization of nano magnetic material in recycle fuel oil. In conclusion, all the nanomaterial investigated in this present review paper shown the positive result where the quality of recycle fuel oil produced meets the standard. In this present review paper shows that among all the nano material investigated in this present review paper, Fe_3O_4 , SiO_2 and Al_2O_3 has great potential to be used as a low-catalyst in recycle fuel oil (RFO)

Keywords:

Recycle Fuel Oil, Nano-Magnetic Material, Desulphurization, Fe_3O_4 , SiO_2 , Al_2O_3

Objectives:

- To review the optimization of nano magnetic material in recycle fuel oil.
- To address the methods used to synthesis the nano magnetic material.

Methodology:

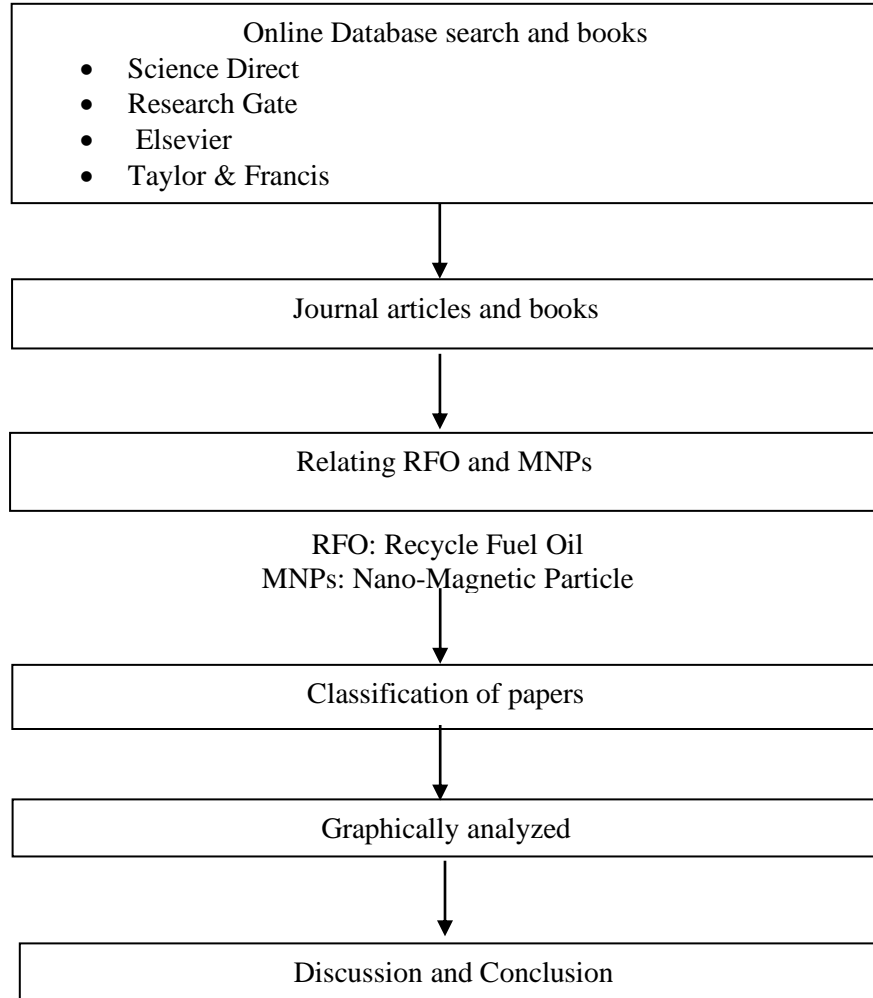


Figure 1 Flow Diagram of Research Methodology

Results:

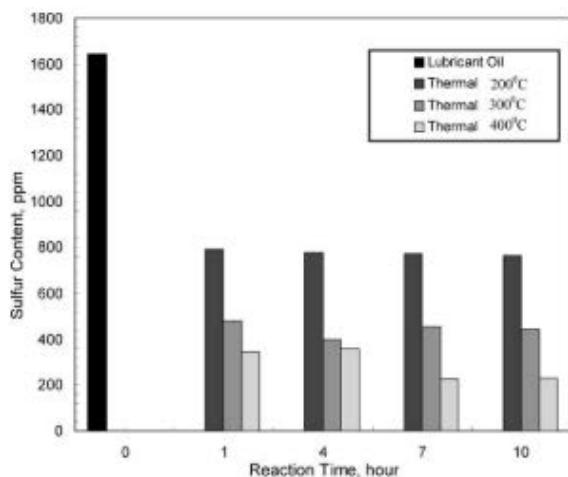


Figure 2 Thermal treatment of waste lubricant oil at various temperature

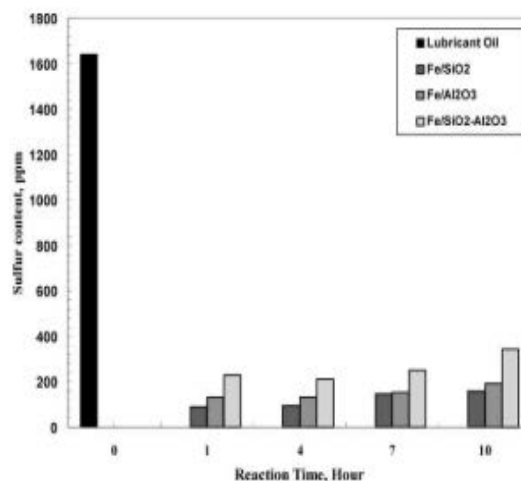


Figure 3 Catalytic treatment of waste lubricant oil with Fe/SiO₂, Fe/Al₂O₃ and Fe/SiO₂-Al₂O₃

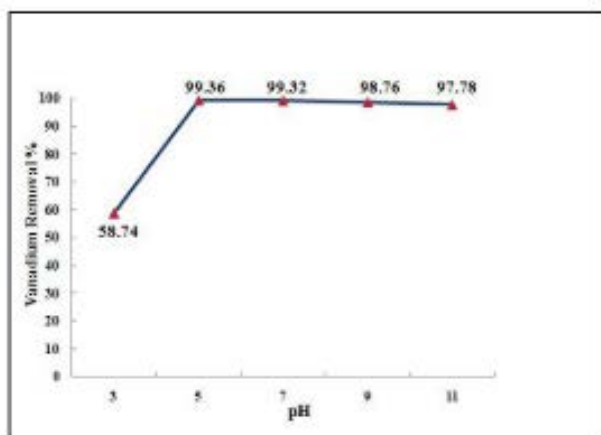


Figure 3 The effect of pH on Vanadium removal efficiency by the HA/Fe₃O₄ nanoparticles

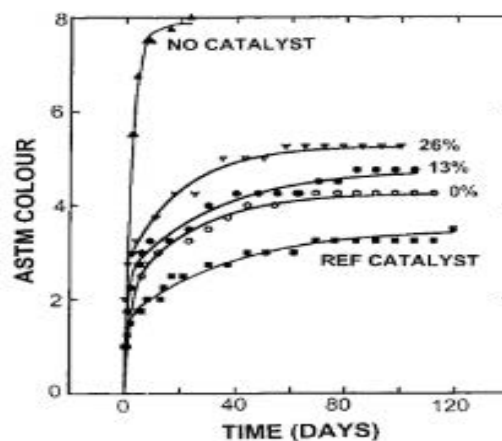


Figure 4 ASTM Colour vs Storage time (4days)

Conclusion:

The treatment of wastes has become one of the most important concern of modern society to protect the environment. The use of lubricating oils or recycle fuel oil in various application is increasing due to it importance's. The presence of heteroatoms such as Sulphur, nitrogen, chlorine and bromine in fuel oil poses serious problems for secondary use as fuel or any other

application. Therefore, the development of suitable methods and catalyst/sorbents for the removal of heteroatoms and to stabilize the storage of the fuel oil is a necessary step. This review paper therefore focuses on the comparison of process condition and chemical characterization of recycle fuel oil (RFO) and optimization of Nano-magnetic material as catalyst/additives leading to the creation of economically viable as well as sustainable feedstock for the production of recycle fuel oil and briefly reviews the optimum process condition of recycle fuel oil (RFO) production. This comparative study presents the findings for effectiveness of the nano magnetic material in enhancing the fuel stability of the RFO. It is observed that by adding nano-magnetic material in recycle fuel oil, desulphurization activity decreases by 95%. MNPs also enhanced the colour degradation of the RFO from dark to lightest color and difference of preparation of catalyst is also one of the factors. Lastly, by adding an MNPs into recycle fuel oil, this study found that the pH value also affecting the fuel stability of the RFO. As mentioned in the results, with additives the pH value increases the removal of vanadium from fuel oil at 0.5mg KOH/g.

SIIC02

MULTIELEMENT EXTRACTION FROM AQUEOUS SOLUTIONS BY PALM KERNEL FATTY ACID DISTILLATE

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Abstract:

Palm kernel fatty acid distillate (PKFAD) was investigated into its potentiality as green extractant for Cu(II), Ni(II), Co(II), Mn(II) and Au(III) extraction from aqueous solutions. The pH-extraction isotherms of various elements by PKFAD were studied at a constant O:A ratio of 1:1. The separation factors of Cu(II) over other elements at pH 4.7 and different O:A ratios (1:1, 2:1, 3:1, 5:1, 10:1) were also studied. Results revealed that the highest Cu(II) (98%), Ni(II) (67.21%), Co(II) (62.38%), Mn(II) (96%) and Au(III) (99%) were achieved at pH 4.7, O:A of 1:1, inert salt concentration of 200 mM and temperature of 25°C. The extraction selectivity of Cu over other elements in descending order was Ni>Co>Mn>Au throughout the different extraction conditions studied. Therefore, PKFAD is a potential green organic solvent for the extraction of different elements from aqueous solutions.

Keywords:

Extraction, Palm kernel fatty acid distillate, Green organic solvent, Cu,Ni,Co,Mn,Au

Objectives:

- To determine the pH-extraction isotherms using single-element solutions at a constant O:A ratio of 1:1.
- To determine the separation factors of Cu over other elements at pH 4.7 at different O:A (1:1, 2:1, 3:1, 5:1, 10:1) in multi-element solutions.

Methodology:

Figure 1 illustrates the process flow on the multielement extraction from aqueous solutions by palm kernel fatty acid distillate.

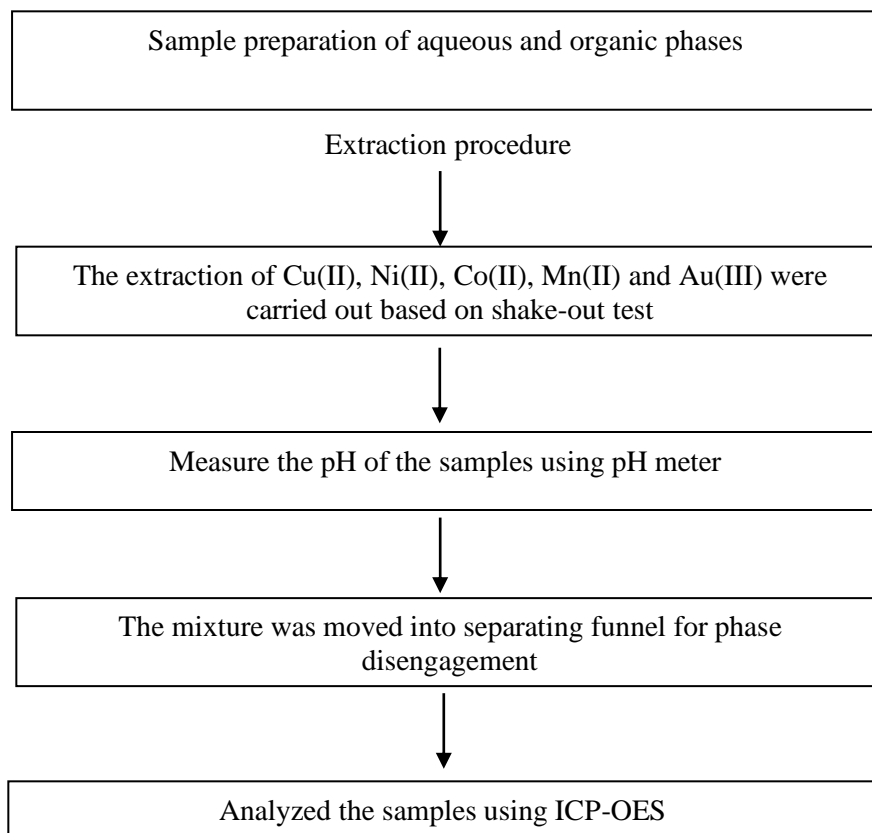


Figure 1 Process Flow of Project.

Results:

Table 1 The extraction efficiency of metal ions with PKFAD.

Metal ions	Extraction efficiency (%E)
Cu(II)	98
Ni(II)	67.21
Co(II)	62.38
Mn(II)	96.73
Au(III)	99

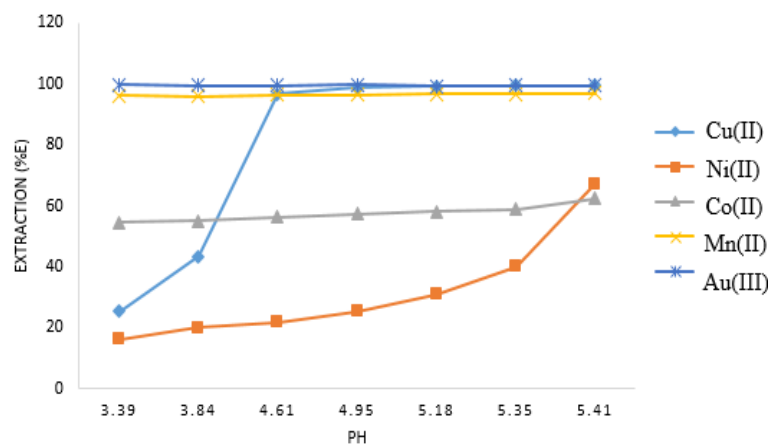


Figure 2 The pH-extraction isotherms of metal ions with PKFAD

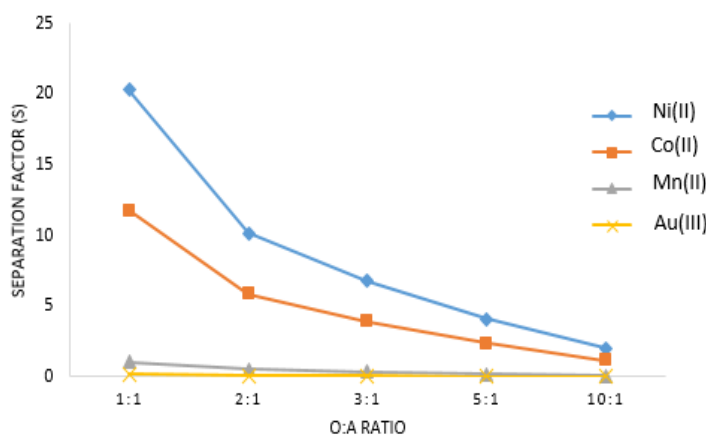


Figure 3 The separation factor (S) of Cu over other elements at pH 4.7 and different O:A ratios

Table 2 Separation factor of Cu over other elements at pH 4.7 at different O:A ratios.

Metal ions	Separation factor (S)				
	1:1	2:1	3:1	5:1	10:1
Ni(II)	20.3	10.15	6.77	4.06	2.03
Co(II)	11.75	5.88	3.92	2.35	1.18
Mn(II)	1.02	0.51	0.34	0.20	0.1
Au(III)	0.20	0.1	0.06	0.04	0.02

Conclusion:

In extraction study, %E of all metal ions were found not to vary with the initial concentrations of 100 mg/L. The extraction efficiency of Cu(II) was found to be 25.47% at pH of 3.39, and increase more than 95% at pH range of 4.61 to 5.41. However, the extraction efficiency of Ni(II) were the lowest compared to other metals. It was found that at pH 3.49, the extraction efficiency of Ni(II) was 16.27%, while the maximum extraction of Ni(II) was 67.21% at pH of 5.12. As for Co(II), the extraction efficiency was less than 60% at pH range of 3.42 to 4.51, while the maximum extraction was 62.38% at pH of 4.7. The extraction of Mn(II) from pH of 3.41 to 4.66 were found to be 96%, and slightly increase to 97% at maximum pH of 4.86. The extraction of Au(III) was achieved up to 99% at all pH range of 3.52 to 4.65.

SIIC03

PRODUCTION OF EPOXIDIZED PALM OIL – DERIVED OLEIC ACID BY USING ACIDIC ION EXCHANGE RESIN (AIER) : EPOXIDATION METHOD AND KINETIC STUDY

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Abstract:

This research done to study the epoxidation reaction for different parameters such as type of catalyst used and agitation speed. The fatty acid content in vegetable oil will undergo epoxidation reaction to produce epoxide. The process start with the formic acid (FA) will react with hydrogen peroxide (H₂O₂) in order to produce performic acid (PFA) in aqueous and side product is water (H₂O). Then, transfer of acid in aqueous ,PFA (aq) to the oil phase, PFA (oil). Meanwhile, the PFA (oil) will react with oleic acid (OA) to produce epoxy oleic acid (EOA) and formic acid (FA) in oil phase. Finally, the transfer of carboxylic acid to the aqueous phase. Besides, kinetic study also be carried by develop a single phase kinetic model to determine the value of kinetic rate constant, k for every reaction via MATLAB simulation. From the results of simulation data, this research highlights on the comparison between experimental and simulation data that has been obtained. In addition, effect of catalyst used and different level of agitation speed on the value of k also has been studied.

Keywords:

Epoxidation, catalyst ,agitation speed, kinetic model, kinetic rate constant, MATLAB simulation

Objectives:

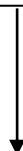
- To develop kinetic model for epoxidation process of palm oil by using MATLAB simulation.
- To study relation parameters for type of catalyst used and agitation speed for the epoxidation process by simulated data.

Methodology:

The process flow illustrate on the epoxidation of palm oil based on kinetic model by using MATLAB simulation and effect of related parameters to the value of kinetic rate constant, k

Objective 1 : To develop kinetic model by using MATLAB simulation

1. Develop differential equation $d[C] / dt$
2. Solve the equation $d[C] / dt$
3. Analyse the results of simulation data
4. Plot graph OOC concentration versus time
5. Comparison between experimental and simulation data



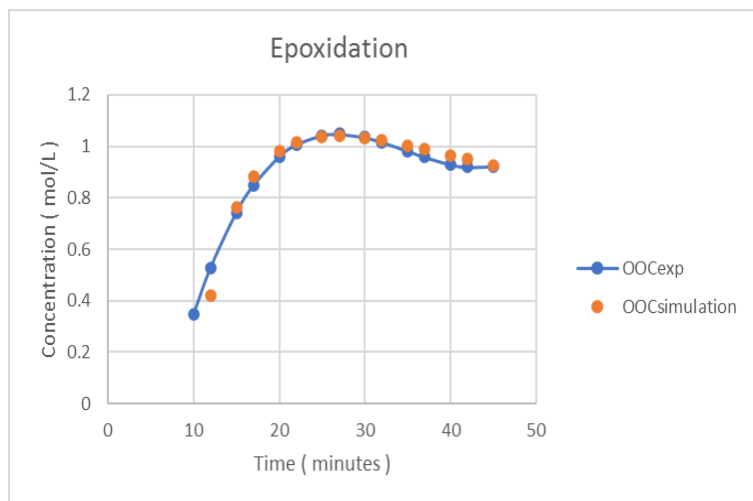
**Objective 2 : To study relation parameters for type of catalyst used
and agitation speed for epoxidation by simulated data**

1. Plot graph value of k versus type of catalyst used
2. Plot graph value of k versus agitation speed

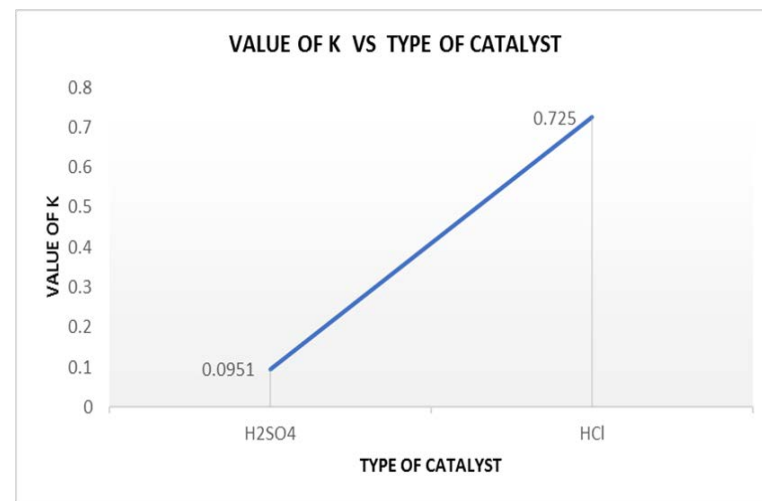
Results:

Table 1 : Results of simulation data

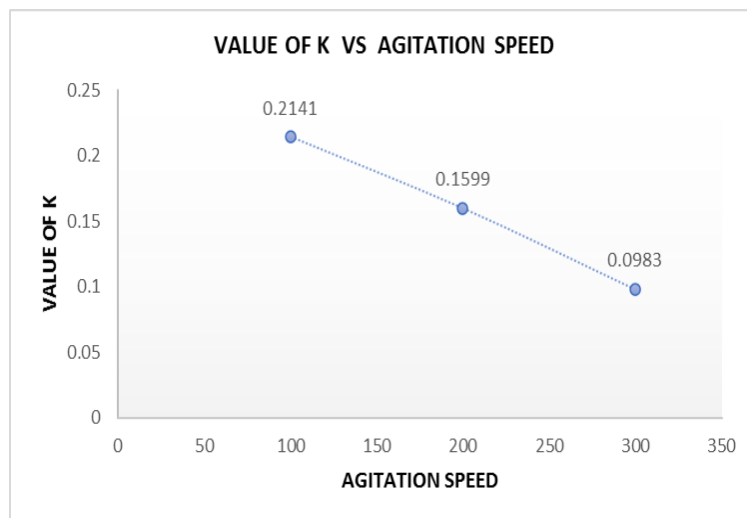
Exp	Initial Concentration			k ₁₁	k ₁₂	k ₂₁	k ₃₁	Error Min	Concentration of Epoxy
	H ₂ O ₂	FA	OA						
1	1.4714	1.4714	2.9484	0.3089	0	0.2141	0	0.1350	0.6086
2	1.4714	1.4714	2.9484	0.2664	0	0.1599	0	0.1098	0.5554
3	1.4714	1.4714	2.9484	14.9454	0.1787	0.0983	0.0479	0.1093	0.7041
4	1.4714	2.9484	2.9484	8.9078	3.2367	0.0951	0.2407	0.1520	0.5399
5	1.4714	2.9484	2.9484	3.4512	5.4238	0.7250	0.0533	0.2501	0.7692
6	1.4714	2.9484	2.9484	14.3052	7.8131	0.2318	0.0010	0.2152	0.6227
7	1.4714	4.4226	2.9484	10.0314	13.1145	0.2685	0.0052	0.1616	0.6181
8	1.4714	4.4226	2.9484	15.0000	0.2208	0.0750	0.5547	0.1008	0.8181
9	1.4714	4.4226	2.9484	4.8041	1.0138	0.2393	0.0029	0.2474	0.6348
10	2.9484	1.4714	2.9484	5.1452	1.1228	0.1584	0.1958	0.1548	0.8159
11	2.9484	1.4714	2.9484	15.0000	0.3457	0.4218	2.4105	0.2720	0.6861
12	2.9484	1.4714	2.9484	14.9916	0.0670	0.1715	0	0.2300	0.6754
13	2.9484	2.9484	2.9484	14.1367	0.2656	0.2851	0	1.8325	1.4702



Graph 1 : Comparison between experimental and simulation data



Graph 2 : Effect of type of catalyst to the value of k



Graph 3 : Effect of agitation speed to the value of k

Conclusion:

There were 13 experiments that being run in the MATLAB simulation to ensure the result with the optimum value. The experimental data that obtained from the previous experiments being used as a raw data for running the simulation . The initial concentration of hydrogen peroxide, formic acid and oleic acid were used the value from the previous experiment as a reference to find value of kinetic rate constant, k . From all the experiments that being run ,experiment 8 was chosen as the best one based on optimized epoxidation result obtained where it recorded the lowest error compared to other experiments which only 0.1008 . The kinetic rate constant for this experiment 8 were $k_{11} = 15.0000$ mol/ L. min, $k_{12} = 0.2208$ mol/ L. min, $k_{21} = 0.0750$ mol/ L. min, $k_{31} = 0.5547$ mol/ L. min . The concentration of epoxy that obtained from this simulation was 0.8181 mol/L.

Based on the graph 1, illustrated the comparison between the epoxy concentration from the lab experiments and simulation based on the kinetics value that were obtained in table 1 . This graph shown the best fit and less error between experiment and simulation data based on experiment 8. The graph also shown the data between experiment and simulation in the formation of epoxidation occurred at the range of 20 minutes to 40 minutes ,there was no significant difference and lower deviation of the predicted simulation data from the experimental data. There were a few ideal assumption made for comparing the simulation data and environmental data by using numerical simulation . The operation in MATLAB simulation did not considered the heat transfer and heat loss during the reaction occur. Since the reaction was rely on overall chemical equation, the reaction of each particles were react at the same time. Meanwhile, in the experimental work, any vaporize gas cannot be determined. The duration for the epoxidation reaction and oxirane ring cleavage may take some time for each reaction to be converged. Furthermore, at 25 minutes the epoxide reaction began to form due to it was the highest peak. But at 30 minutes the reaction began to degrade where the simulation cannot be fitted to the experiment data. Due to the different in fundamental between the experiment and simulation where experimental work provided new empirical data while simulation cannot. The graph gradually increases alongside the reaction until the formation of epoxide. It was due to the concentration of formic acid causes the reaction rapidly increase and the epoxy yield also increase.

In epoxidation process, the effect of catalyst used lead to the different result on reaction rate as shown in graph 2. The strong concentration of catalyst used gives impact to the reaction rate where the higher concentration of catalyst will lead to the increasing value of reaction rate. With the higher concentration of catalyst lead to increase of the total surface area and total active sites in the reaction mixture, then increased the rate of the epoxy ring cleavage. Since the kinetic rate of epoxidation is proportional to the number of active sites, the value of k also increase. Based on the graph 2 ,hydrochloric acid (HCl) recorded the highest value of k by 0.725 while sulfuric acid (H₂SO₄) recorded the lowest value by 0.0951 . The number of oxirane content was higher by using HCl acid because H⁺ ion of HCl could move freely so that it influenced the reaction to operate at optimum condition. The molecules of the reaction could collide with each other and enhance the kinetic rate of epoxidation reaction. Hydrochloric acid was classified as the most strong catalyst used in this epoxidation reaction. Besides, it was observed that with the

increasing of catalyst concentration lead to the formation of oxirane oxygen, increase the double bond conversion and higher epoxy yield. Hence, HCl was the best homogeneous catalyst for acidic ion exchange resin with high selectivity to the reaction formation of epoxides .

To determine the effect of agitation speed on oxirane oxygen content (OOC) value of epoxide, there were three different level of agitation speed which were at 100 rpm, 200 rpm, 300 rpm as shown in the graph 3. In general, the degree of agitation speed increased the turbulence and surface area allows to the higher interfacial areas and mass transfer that occur between two different phases of the reaction. Thus, value of k also increase. For agitation speed, the relative conversion to oxirane (RCO) increase until reached the maximum limit with the increasing of the level of agitation speed. The highest value of reaction rate, k was at 100 rpm with the value of k at 0.2141. The lower value of k due to the slow agitation speed that cause a lower turbulence or due to the degradation of epoxide start to occur. The decreasing of reaction rate at 200 rpm with the value of k , 0.1599 and at 300 rpm with the value of k , 0.0983 may due to degradation of oxirane oxygen content. It was assumed that the reaction was free from mass transfer resistance under the given circumstance. Since the agitation speed was good and the reaction was under isothermally condition, the diffusional resistance between the different phase of aqueous phase and oil phase of performic acid reacted with oleic acid to form epoxidized oleic acid can be ignored.

SIIC04

A STUDY OF CO₂ METHANATION OVER NICKEL BASED CATALYST- A REVIEW

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Abstract:

The population has rapid growth as a result of increased resource utilization presently. The energy consumption from carbon contain substance resulted in harmful effect to the atmosphere due to high in concentration of carbon dioxide (CO₂) and greenhouse effect as carbon gasses emitted. There are actions have been taken to control the CO₂ emission by converting CO₂ through methanation process which is that a reaction between carbon dioxide with hydrogen at exothermic condition. The main objective of this research project is to review and determine which catalyst combination shows the most excellent outcome of reaction. Review on X-ray powder Diffraction (XRD) and H₂ temperature Programmed Reduction (H₂-TPR) of nickel-based catalyst on the dispersion and reduction of nickel particle when methanation occur. From the review, it shows that several of support effects the catalyst dispersion and reduction. Unsupported Ni based catalyst show good response to the analysis but still supported Ni based catalyst show more stable reaction and good conversion on CO₂ methanation.

Keywords: CO₂, Methane, Ni, H₂, Methanation

Objectives:

1. To review study on unsupported and supported nickel-based catalyst for CO₂ methanation.
2. To determine the best condition and combination of nickel-based catalyst for its physico-chemical properties using different type of analysis.

SIIC05

COMPARATIVE STUDY ON CALIXARENES IN DRUG ENCAPSULATION AND DELIVERY

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Abstract:

Calixarene, a macrocyclic compound which was discovered as the by-product from the condensation of phenol-aldehyde, satisfied the requisite in the development of drug designing and synthesis of biological compound. Their basic molecular structure has high potential in molecule and ion recognition which allow maximum interaction between host molecules and guest molecules. The presence of hydrophobic cavities that hold the capability to hold small ion or molecules allow the encapsulation of guest drug. The potentials that calixarenes have shown in biomedical field through diversified the features and structures, give rise to wide application in drugs delivery. This paper reviews the applications of calixarenes in drug encapsulation and delivery.

Keywords:

Macrocyclic compound, Hydrophobic cavities, Drug encapsulation, Drug delivery

SIIC07

EXTRACTION OF HIBISCUS ROSA SINENSIS LEAVES USING ULTRASONIC WATER BATH IN DETERMINING THE PHENOLIC CONTENT.

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Abstract:

Hibiscus rosa-sinensis grows at many places around the globe. *Hibiscus rosa-sinensis* contains numerous classes of auxiliary metabolites, counting flavonoids, anthocyanins, terpenoids, steroids, polysaccharides, alkaloids, amino acids, lipids, and naphthalene group. Different kind of studies show that parts of *Hibiscus rosa-sinensis* plants possess antioxidant, antimicrobial, antidiabetic, antiulcer, hepatoprotective, antifertility, antigenotoxic and anti-inflammatory properties that help in treatment of many diseases. Therefore, *Hibiscus rosa-sinensis* plant has been identified as one of many medicinal plants that possesses various potential in therapeutic applications. Bioactive compound extraction on plants done by several methods like conventional method, Microwave Assisted Extraction (MAE) method etc. However, none of the study has been done on extraction of bioactive compounds extracted from *Hibiscus rosa-sinensis* leaves using Ultrasonic Assisted Extraction (UAE) method. Hence, there is essential to investigate on the benefits of the *Hibiscus rosa-sinensis* leaves for the future used by using UAE method for extraction. The objectives of this study are to extract bioactive compound extract from *Hibiscus rosa-sinensis* leaves by using ultrasonic water bath using different solvents like ethanol, methanol, ethyl acetate and acetone and to analyse phenolic profile from the extract. The solvent is chosen based on the polarity due to the presence of hydroxyl group in determining the phenolic compound. *Hibiscus rosa-sinensis* leaves is prepared by drying at 50°C and pestled before extraction by different solvent. After that, the sample is placed in ultrasonic water bath at different time (5 min, 15 min, 30 min, 45 min, 60 min) and then the solvent is removed by using rotary evaporator. The result shows the highest extraction yield by UAE method is methanol and

then followed by ethanol, acetone, and ethyl acetate. After extraction, UV-VIS spectrophotometer was used to determine the phenolic content in *Hibiscus rosa-sinensis* leaves. Even though methanol has the highest yield of extraction, it is not the best solvent to determine the phenolic content when comparing it with standard calibration curve of Gallic acid. However, as for ethyl acetate, it has the lowest extraction yield but able to determine the phenolic content. As a conclusion, the yield of extraction does not affect the determination of the phenolic content.

Keywords:

Hibiscus rosa sinensis, Folin-Ciocalteu method, DPPH (1, 1-diphenyl-2-picrylhydrazyl) assay , phenolic compounds, flavonoids.

Objectives:

- To extract bioactive compound extract from *Hibiscus rosa sinensis* leaves by using ultrasonic water bath using different solvents like ethanol, methanol, ethyl acetate and acetone.
- To analyze antioxidant and phenolic profile from the extract.

Methodology:

Figure 1 The process flow on the process of extraction by Ultrasonic Assisted Extraction (UAE) method.

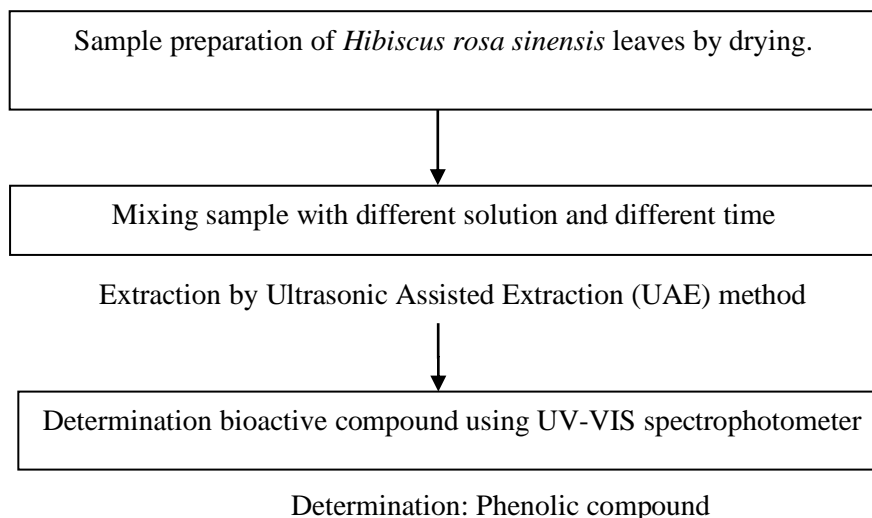


Figure 1 Process Flow of Project.

Results:

Table 1 Yield of extraction of Hibiscus rosa sinensis by using solvents (methanol, ethanol, acetone, and ethyl acetate)

Time (min)	Weight of sample after extraction (g)				Extraction Yield (%)			
	Methanol	Ethanol	Ethyl acetate	Acetone	Methanol	Ethanol	Ethyl acetate	Acetone
5	102.87	102.80	102.78	102.76	13	6	4	3
15	102.89	102.81	102.77	102.76	15	7	3	2
30	102.94	102.82	102.77	102.76	20	8	3	2
45	102.98	102.82	102.77	102.80	24	8	3	6
60	102.87	102.82	102.76	102.77	13	8	2	3
Average yield (%)					17	7.4	3	3.2

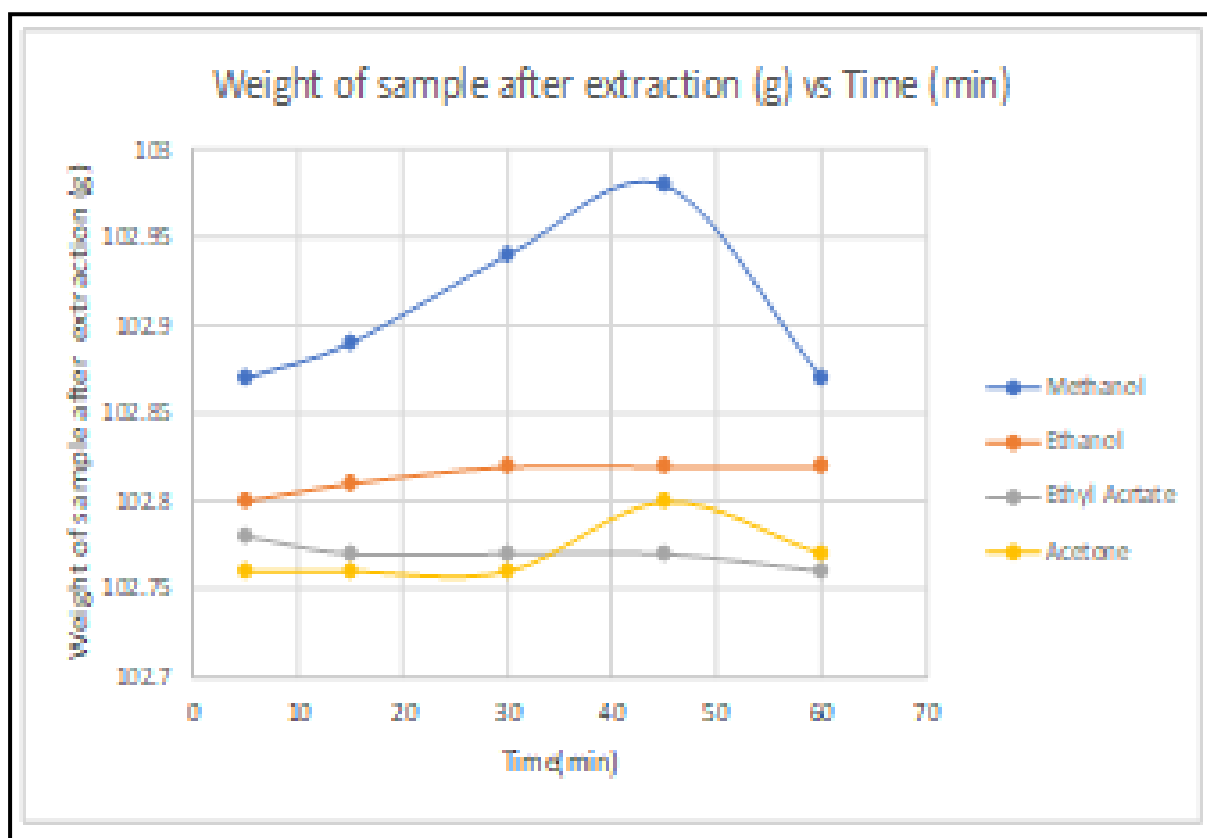


Figure 2 The weight of extraction over time

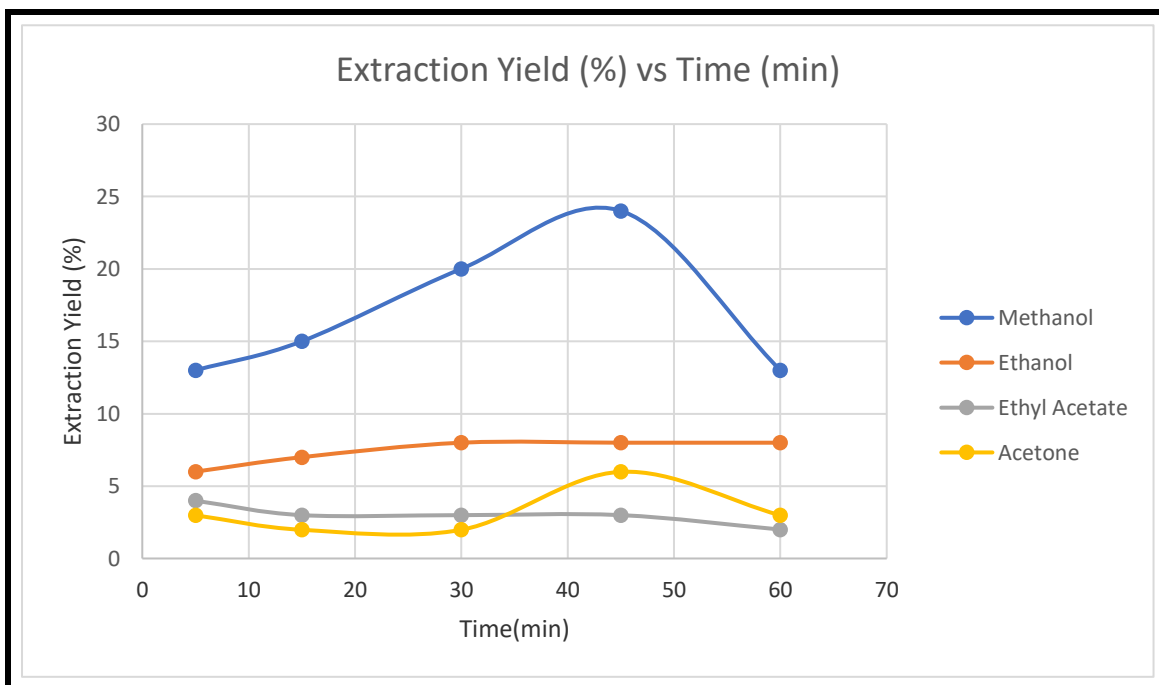


Figure 3 The Extraction yield over time

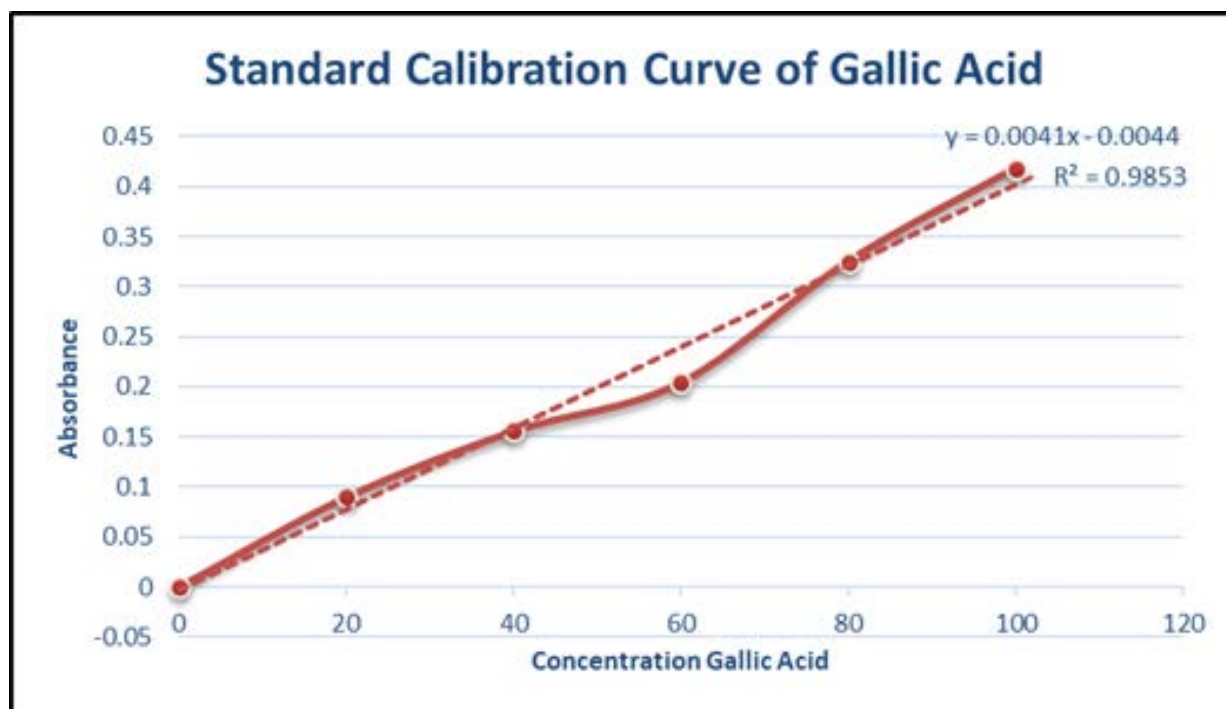


Figure 4: Standard calibration curve of Gallic Acid

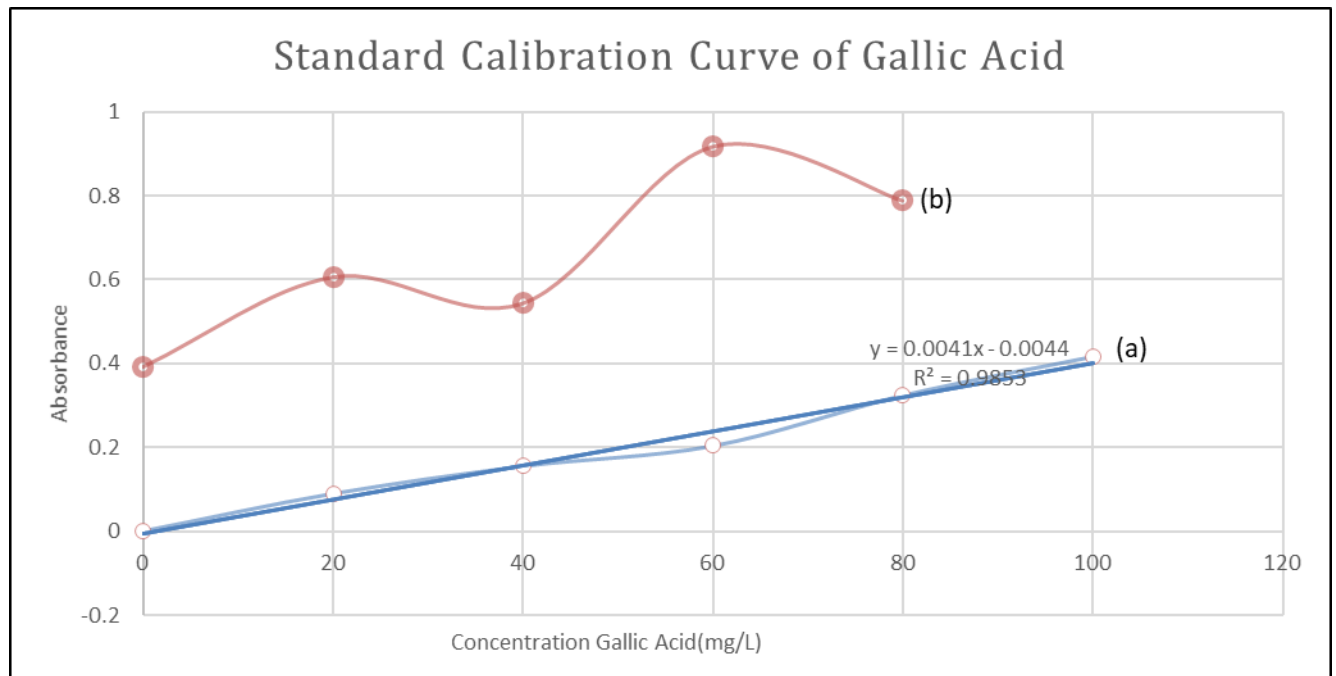


Figure 5: Standard calibration curve Gallic Acid (a) Standard calibration line (b) Ethanol

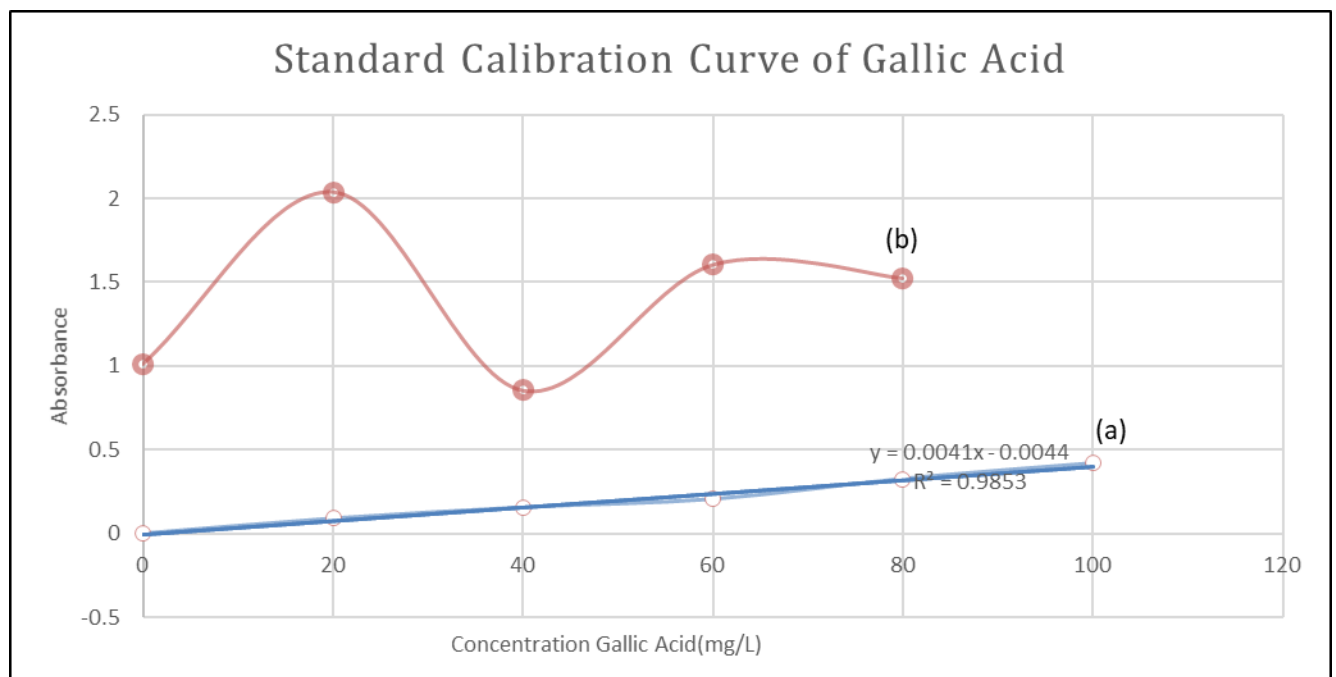


Figure 6: Standard calibration curve Gallic Acid (a) Standard calibration line (b) Methanol

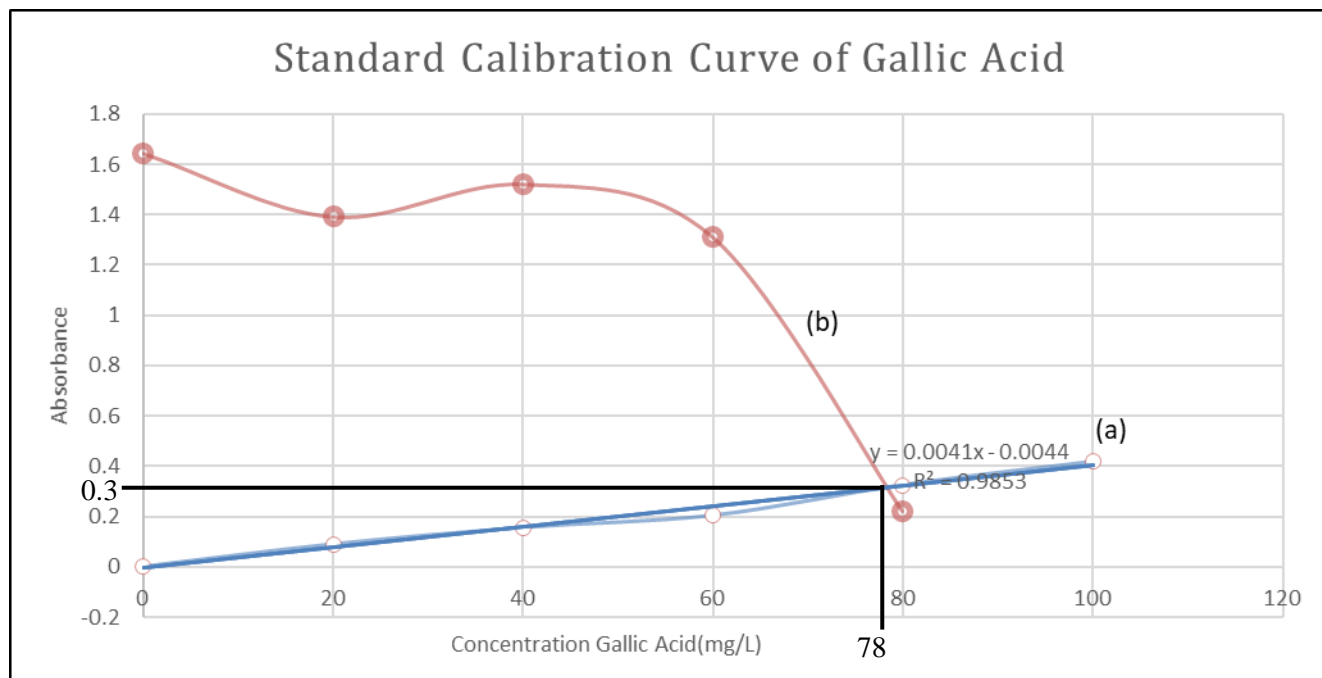


Figure 7: Standard calibration curve Gallic Acid (a) Standard calibration line (b) Acetone

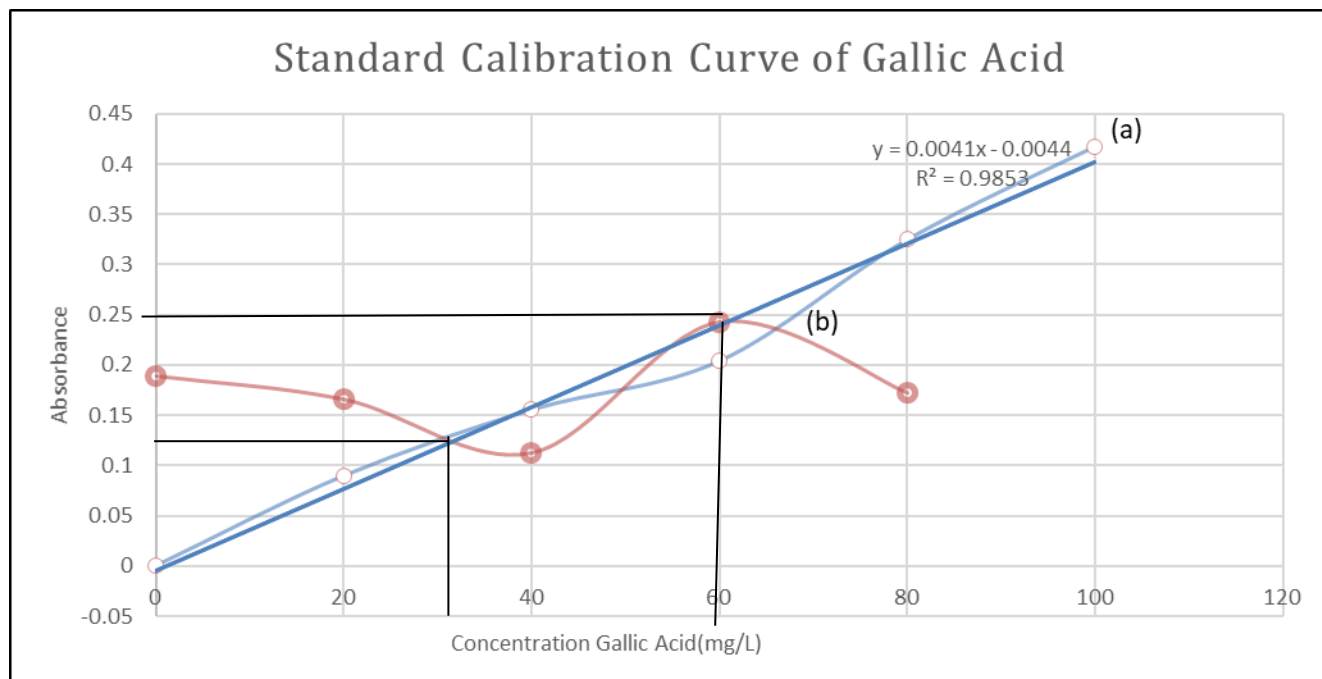


Figure 8: Standard calibration curve Gallic Acid (a) Standard calibration line (b) Ethyl Acetate

Conclusion:

Hibiscus rosa sinensis possess many benefits and it is known to be used as anti-fertility, anti-diabetic, antioxidant, anti-microbial, anti-inflammatory, and anti-pyretic activities. The Ultrasonic Assisted Extraction (UAE) methods is simple, rapid, environmentally friendly, and comprehensive. Table 1 shows the result of extraction yield by using Ultrasonic Assisted Extraction (UAE) method. The method of extraction is simple, inexpensive and convenient to use. Ultrasonic water bath facilitates the extraction of organic and inorganic compounds from solid matrices using liquid solvents. Sonication is the production of sound waves that create cavitation bubbles near the sample tissue, which break down to disrupt cell walls, thereby releasing cell contents. The highest weight after extraction is 102.95 g for methanol at time (30 min), while the lowest weight after extraction belongs to acetone at time (5 min, 15 min and 30 min) by 102.76 g and ethyl acetate at time (60 min). From the average of extraction yield in Table 1, methanol has the highest yield of extraction and the lowest extraction yield is ethyl acetate. Methanol has been generally found to be more efficient in extraction of lower molecular weight polyphenols. That is why, methanol has the highest extraction yield. The graph of the weight of sample after extraction and extraction yield by different solvent can be seen in Figure 2 and Figure 3. However, as for ethyl acetate, it has the lowest extraction yield but able to determine the phenolic content. Figure 4 shows standard calibration curve of Gallic acid where $Y = 0.0041 X - 0.0044$ and $R^2 = 0.9853$. After preparing standard calibration curve for Gallic acid, the sample is tested with UV-VIS spectrophotometer to determine the phenolic content. Figure 5 until Figure 8 shows the result of phenolic content by comparing it with standard calibration curve. Figure 7 shows the result of using acetone as a solvent to determine the phenolic content. At absorbance 0.3 and concentration at 78 mg/L the phenolic content can be determined by acetone. Figure 8 shows phenolic content test by using ethyl acetate as a solvent. From the graph, it shows that at concentration between 20 and 40 mg/L and at 60 mg/L the phenolic content is observed. As a conclusion, the yield of extraction does not affect the determination of the phenolic content.

SIIC08

PRODUCTION OF EPOXIDIZED PALM OIL DERIVED OLEIC ACID BY USING PERACID MECHANISM

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Abstract:

Epoxidation study has changed a lot in world consumption of raw material where the cost-effective and eco-friendly product is much safer for consumer to use. This practice is very reliable to achieve the increasing demand in every consumer especially in vegetable oil. Epoxidation of oleic acid was carried out by in situ performic acid to produce epoxidized oleic acid with enzymatic reaction. Since epoxide ring is highly reactive where the degradation of the oxirane was tested by using hydrogen peroxide, formic acid and water. The degradation of the epoxide is mainly focus on the rate of reaction between molar ratio of chemical. Thus, the study on degradation of the epoxide is lacking. With the initial concentration of formic acid at 1.4714 mol/L, while hydrogen peroxide and oleic acid are 2.948 mol/L respectively. Then, the kinetic rate, k parameters obtained $k_{11}= 6.6642$, $k_{12}= 11.0185$, $k_{21}= 0.1047$, for epoxidation palm oleic acid, and $k_{31}= 0.0538$ in epoxidation process. The minimum error of the simulation is 0.0967. Besides, optimizing molar ratio between the chemical was done through epoxidation and the optimum condition obtained are H_2O_2/OA unsaturation molar ratio and FA/OA molar ratio with the temperature of 35°C (level 1), agitation speed at 100 rpm (level 1) specifically.

Keywords:

Epoxidation, Kinetic Rate, Matlab, Molar Ratio

Objectives:

- To develop kinetic model of epoxidation of palm oil by Genetic Algorithm through MATLAB simulation.
- To study the effect of rate constant to molar ratio of hydrogen peroxide and formic acid based on kinetic data.

Methodology:

The flow of methodology based on the objective. From this experiment, all method is using through comparative study by MATLAB software and data is used from the previous study. The parameter is chosen by number of molar ratio between hydrogen peroxide, oleic acid and formic acid. The parameter is chosen by number of molar ratio between hydrogen peroxide, oleic acid and formic acid. The value of kinetic, k will be varies between molar ratio of this chemical into number of epoxy obtained with minimum error will selected. All the value will be discuss based on plotted graph between molar ratio and value of k .

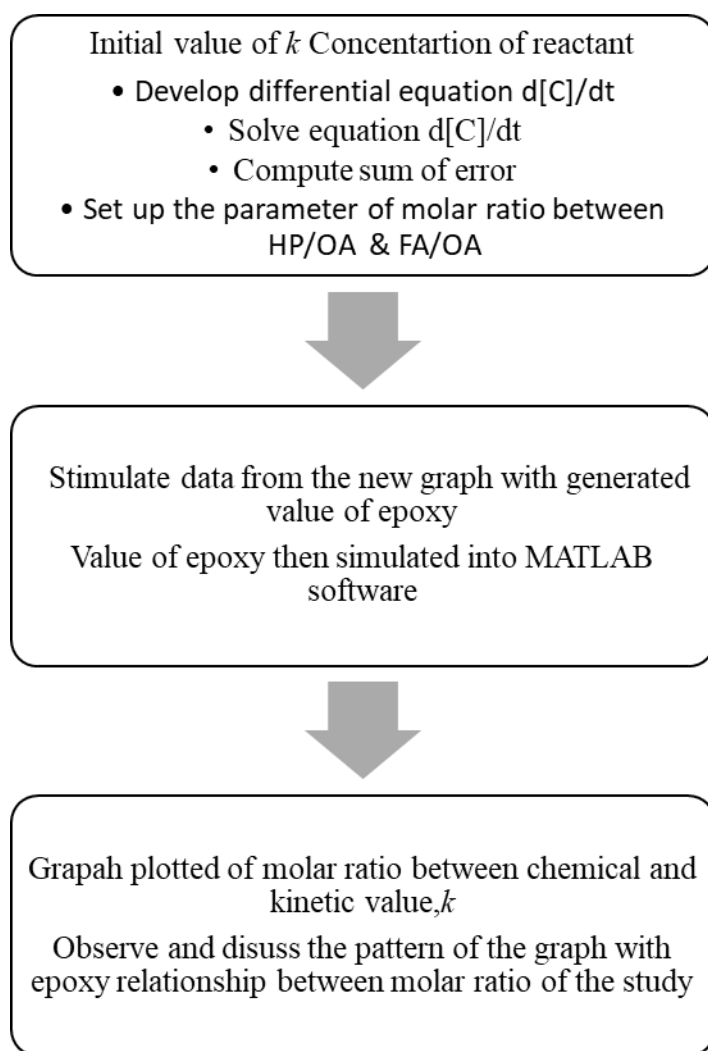


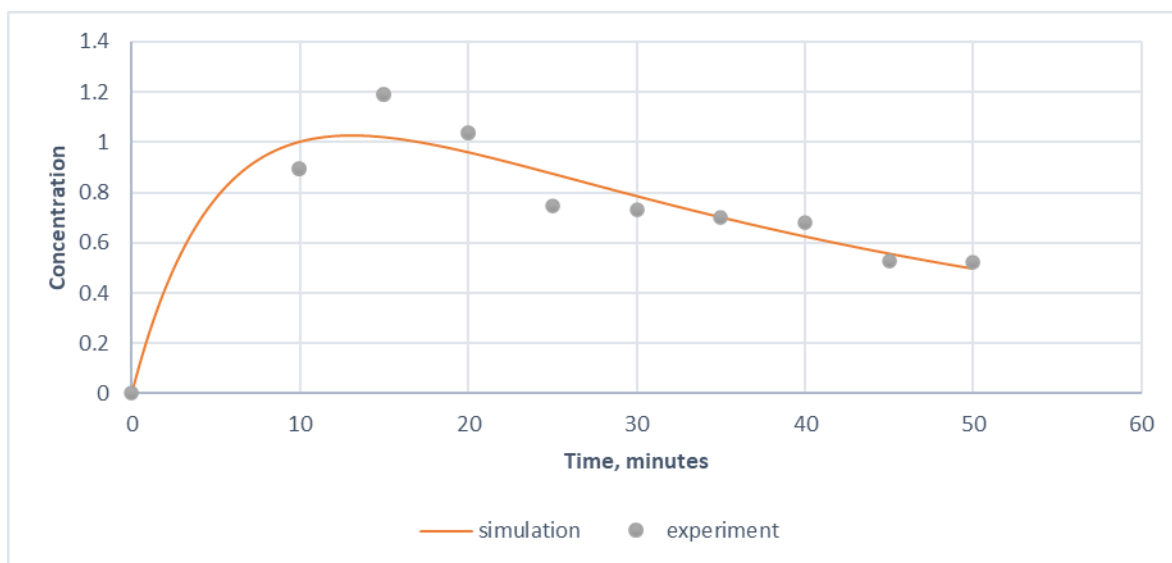
Figure 1 illustrate the process flow of epoxidation process of kinetic study and molar ratio of Hydrogen Peroxide and Formic Acid to Oleic Acid Concentration.

Parameters		Levels		
		1	2	3
A	H ₂ O ₂ /OA unsaturation molar ratio	0.5	1	1.5
B	FA/OA unsaturation molar ratio	0.5	1	1.5

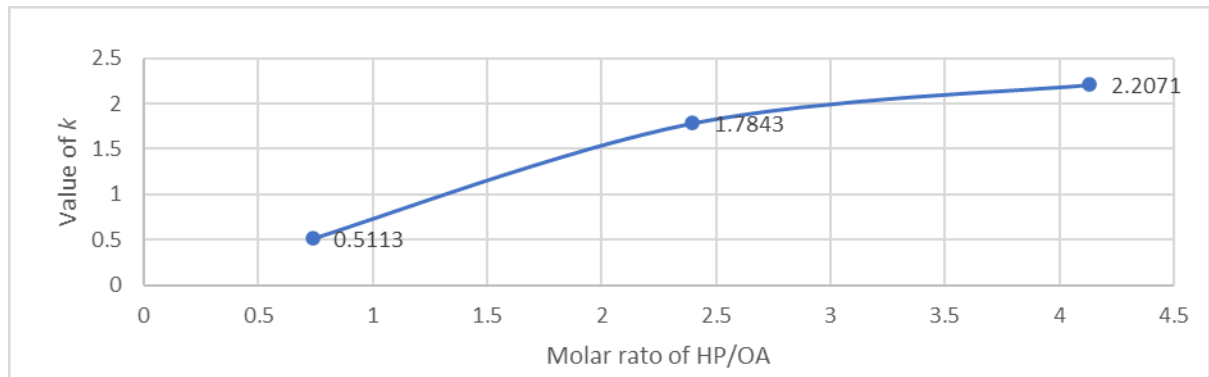
Figure 2 illustrates the molar ratio of the between Hydrogen Peroxide and Formic Acid to Oleic Acid

Results:

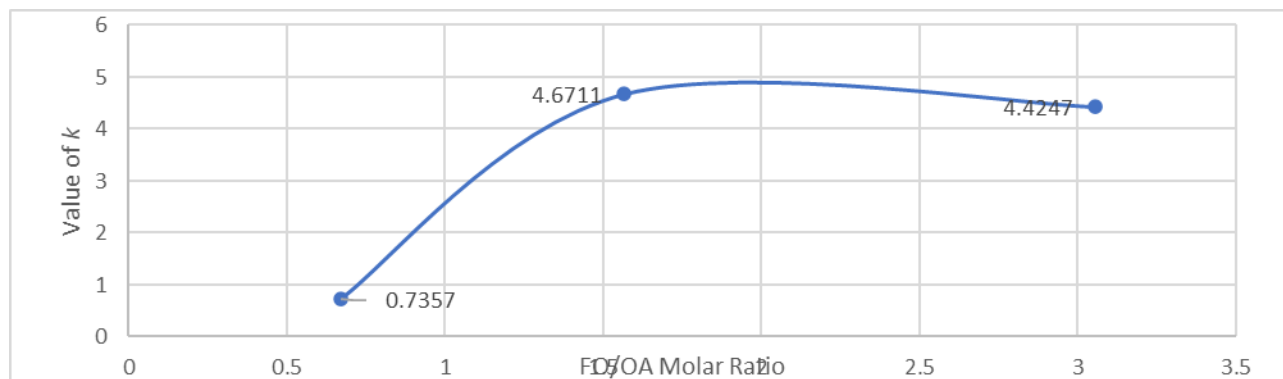
Graph 1: Comparison between simulation and experimental data.



Graph 2 : Parameter of Hydrogen Peroxide to Oleic Acid Molar Ratio



Graph 3: Parameter of Formic Acid to Oleic Acid Molar Ratio



Conclusion:

This study had shown that the formation of epoxidized oleic acid palm oil successfully represents the experimental data. In addition, the kinetic model of palm oil with molar ratio of the chemical represented with value of $k_{11} = 6.6642$ mol/L.min $k_{12} = 11.0185$ mol/ L. min, $k_{21} = 0.1047$ mol/ L. min and $k_{31} = 0.0538$ mol/ L. min of epoxidation process. Besides that, all the process involved epoxidation and degradation with each reaction and were successfully simulated by using MATLAB simulation. The minimum error of simulation for this study is

0.0967% which consider good and all the generated simulation from relation of molar ratio obtained successfully formulated from the equation. As from the equation, all the reactants will be used up and the product will have increase value of concentration. Thus, the kinetic model is valid, and the objective might vary from the previous study. It also can be concluded also that the finding of this study is comparable with the result of previous study.

In addition, the number of molar ratios optimized by using MATLAB software help to precise the minimum error of the experiment. The kinetic modelling successfully represents epoxidation and epoxidation process. The factors that have been decided which were H₂O₂/OA unsaturation molar ratio of 1:1 (level 2), FA/OA unsaturation molar ratio 0.5:1 (level 1), temperature of 35°C (level 1), agitation speed at 100 rpm (level 1) specifically. From these values, the relation of molar ratio between all chemicals can be achieved.

SIIC09

PRODUCTION OF HIGH QUALITY BIO-OIL VIA PYROLYSIS OF LIGNOCELLULOSIC BIOMASS: A REVIEW ON ROLE OF PLASTIC AND CATALYST TYPES

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Abstract:

Biomass is one of the alternatives and sustainable source of energy that exists in abundant, renewable and widely available, as well as emits particularly low CO₂ content. It can be used to produce biofuels via the pyrolysis process, which is an environmentally safe way of employing biomass and solid wastes. Moreover, co-pyrolysis of biomass and plastic produced significant positive effect, as the bio-oil obtained has high calorific value close to conventional fuel. By utilizing the biomass and plastic waste as co-reactants help to reduce the fuel consumption and alleviate the environmental pollution. However, elimination of oxygenated compounds poses a considerable challenge. Catalytic co-pyrolysis is utilized to enhance the quality of biofuel produced from co-pyrolysis of biomass and plastic. The catalytic co-pyrolysis process involved two materials as feedstock and an acidic catalyst for production of biofuel. This technique promotes the production of high-quality bio-oil through acid catalyzed reduction of oxygenated compounds and mutagenic polyaromatic hydrocarbons. This paper review on the role of plastic and catalyst types for the production of high-quality bio-oil via pyrolysis of lignocellulosic biomass. This review focuses on the potential of plastic such as HDPE, LDPE, PET, PC, PVC and PS as co-feed in co-pyrolysis to produce valuable liquid fuel. Also, to study the types of zeolite-based catalyst to further improve the process and the quality of biofuels in catalytic co-pyrolysis of biomass and plastic.

Keywords:

Lignocellulosic Biomass, Plastic, Co-pyrolysis, Catalytic co-pyrolysis, Zeolite catalyst

Objectives:

- To review the potential of plastic as co-feed in co-pyrolysis of biomass for the production of high-quality bio-oil
- To study the performance of zeolite-based catalyst work in catalytic co-pyrolysis of biomass and plastic.

Methodology:

Collection data for the study was conducted through extensive search for peer-reviewed academic articles published in the year 1999 to 2020 period, with extra information provided from external sources such as government and market-research sources. The search is performed by several set of keywords in various academic databases such as Science Direct, Research Gate, Elsevier, Academia, SpringerLink, American Chemical Society (ACS) Journals and Scopus. The general keywords for searching terms are “Pyrolysis of Lignocellulosic biomass”, “bio-oil, co-pyrolysis”, “catalytic co-pyrolysis”, “plastic” and “catalyst” and lastly, the literatures obtained were filtered according to the publication year

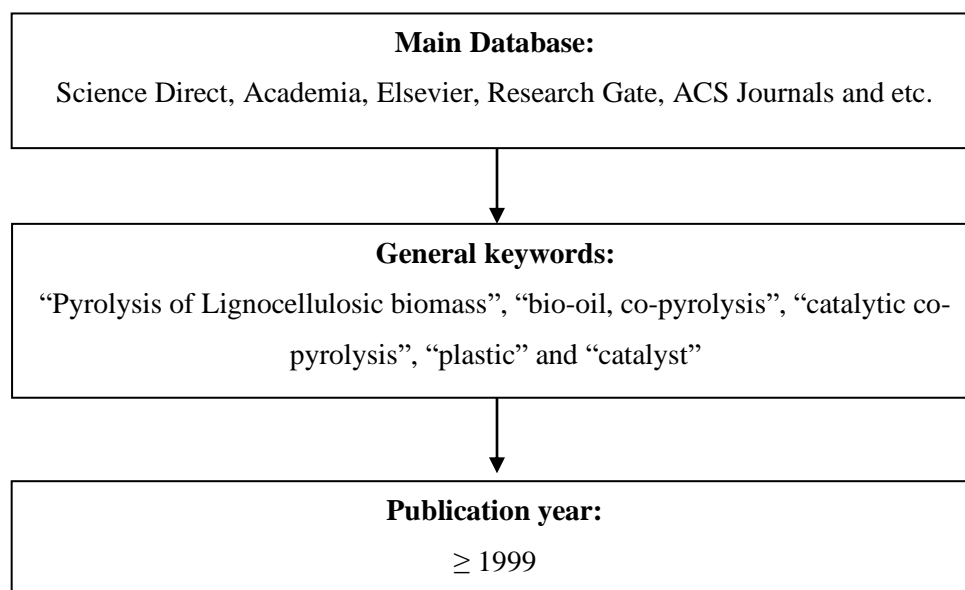


Figure 1 illustrates the process flow on the production of high quality bio-oil via pyrolysis of lignocellulosic biomass: A review on the role of plastic and catalyst types.

Results:

Table 1: Condition for operating parameters and products for three types of pyrolysis for pyrolysis of lignocellulosic biomass [27,28].

Pyrolysis Process	Solid Residence Time (s)	Heating rate (K/s)	Particle size (mm)	Temp. (K)	Product Yield (%)		
					Oil	Gas	Char
Slow	450-550	0.1-1	5-50	550-950	30	35	35
Fast	0.5-1.0	10-200	<1	850-1250	50	20	30
Flash	<0.5	>1000	<0.2	1050-1300	75	12	13

Table 2 : Bio-oil yield obtained from the previous studies on co-pyrolysis of biomass with plastic (HDPE,LDPE,PET,PC,PVC & PS).

Type of materials		Characteristic		Compound presence	Bio-oil Yield (wt%)	References
Biomass	Plastic	Temperature	Blending Ratio			
Almond shell	HDPE	500	1:1, 1:2, 2:1, 1:0	Aliphatic hydrocarbon	40-50	[47]
Sugarcane Bagasse	HDPE	600	3:2	Aliphatic compounds & Higher Carbon and Hydrogen content	63.7	[52]

Sugarcane Bagasse	LDPE	500	1:1	Less oxygenated compounds, phenol and acidic compounds	52.75	[7]
Hazelnut shells	PET	500	1:1	Mainly liquid and gas products and no char formation was observed	29.9	[49]
Walnut shells	PET	500	1:1	Mainly liquid and gas products and no char formation was observed	28.9	[49]
Rice straw	PET	550	1:1	Aldehyde, ketones, acids, aromatics, and phenol	36	[5]
Cotton stalk	PET	500	1:1	Mainly liquid and gas products and no char formation was observed	25.9	[49]
Klason annual plants & Organosolv hardwood	PC	500	1:2	significant amounts of syringol, methylsyringol and isovanillic acid	46	[50]
LignoBoost Lignin	PC	500	1:1	More guaiacol and its methyl- and ethyl- derivatives	48.5	[51]
Xylan	PVC	400-600 °C	1:1	Char, Light aromatics and High oxygenated	14.9	[53]

				products		
Walnut shells	PVC	500	1:1	Mainly liquid and gas products, and a negligible amount of char	17.6	[54]
Pine cone	PS	500	1:1	Aliphatic & Aromatic hydrocarbon	52.3	[55]
Pine sawdust	PS	500	3:1	Aliphatic & aromatic hydrocarbons.	63.3	[56]
Palm shell	PS	600	3:2	Aliphatic & aromatic hydrocarbons.	68.3	[57]

Table 3: Performance of various zeolite-based catalyst on catalytic co-pyrolysis of biomass and plastic.

Catalyst types	Preparation of catalyst	Catalyst Effect	Reference
Microporous and mesoporous zeolite	Catalyst prepared by post-synthesis treatment.	Coke was found inside the micropores of ZSM, However, coke formation reduced up to 65% by using mesoporous catalyst. Mesoporous catalyst doubled the selectivity of mono-aromatic compounds, increased the aromatic yield and decreased the coke yield.	[58]
Metal modified zeolite	Catalyst prepared by wet impregnation method	Improve the activity of the zeolite catalyst, promote the deoxygenation of oxygenated compounds during pyrolysis and increase the content of aromatic.	[10]

Hierarchical zeolites <ul style="list-style-type: none">• Micro-mesoporous composite• mesoporous	Micro-mesoporous catalyst prepared by Alkaline extraction of zeolites. Meanwhile, hierarchical mesoporous catalyst prepared by template free method.	Improved surface acidity favors large molecules catalytic. Hierarchical mesoporous zeolites exhibit high catalytic activities in cracking of large molecule, high hydrogen adsorption and high hydrothermal stability compared to Micro-mesoporous zeolite.	[59]
Low-cost mineral based catalyst <ul style="list-style-type: none">• Red mud• Fly Ash• Steel waste• Industrial sludge	Mineral generally being converted into zeolite-based catalyst or added into zeolite in two-stage pyrolysis.	Delivering higher gas yields and lower viscosity bio-oils than a ZSM-5 zeolite catalyst. Also, produced significantly higher organic liquid yield and reduced gas and coke yields.	[60]

Conclusion:

The roles of plastic as co-feed and catalyst types for a production of high quality bio-oil via pyrolysis of lignocellulosic biomass were reviewed in this paper. Pyrolysis is a promising technology to convert lignocellulosic biomass into liquid biofuel, which can reduce the dependence on fossil fuels in the future. However, there are some disadvantages of pyrolysis bio-oil, such as high oxygen content, high acidity, low calorific value and poor stability. Thereby, plastics is added as an additive material or co-reactant which act as hydrogen donors in thermal co-pyrolysis. Co-pyrolysis of plastic and biomass produced a significant positive effect as the bio-oil obtained has high calorific value close to conventional fuel. Moreover, co-pyrolysis was reviewed from the point of major plastics such as PET, HDPE, PVC, LDPE, PC and PS. Study was further reviewed by the addition of zeolite-based catalyst types in catalytic co-pyrolysis of biomass and plastic. It shows an excellent aromatization and alkylation ability, which can improve the yield and selectivity of aromatics and other products contributing to enhance improvement of the bio-oil quality.

SIIC10

COMPARISON OF COFFEE WASTEWATER TREATMENT TECHNOLOGIES

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Abstract:

Coffee is an agricultural commodity of substantial socio-economic importance that creates jobs both directly and indirectly, including employment contracts in rural areas and taxes on production. The processing of coffee can have a significant influence on the world economy. The process of coffee cherry has caused environmental issues due to discharges of huge amounts of organic waste and high concentration of contaminants in the effluent. The purpose of wastewater treatment is to protect the environment in a manner that is commensurate with public health and socio-economic concerns. Thus, an effective system or technique is proposed to meet the effluent standard for discharge of coffee wastewater from processing plant. There are different study reports for the treatment of coffee processing effluents. The reviews for the coffee wastewater treatment applied included the technology applied either in the lab experiment or tested on pilot plant simulation. The treatment methods introduced such as chemical coagulation/flocculation, advanced oxidation processes (photo-fenton oxidation), adsorption, anaerobic digestion, phytoremediation (wetland system) and ionizing irradiation (gamma radiation). All these reports stated the scientific approaches while applying treatment/management options for coffee processing. This review focuses on the most potential of treatment applied on coffee wastewater treatment based on Biochemical Oxygen Demand (BOD) reduction and Chemical Oxygen Demand (COD) reduction in coffee wastewater.

Keywords:

Coffee Wastewater, Methods, Biochemical Oxygen Demand, Chemical Oxygen Demand, Potential Treatment

Objectives:

The main objective of this review is to study the performance of various method and technologies in treating coffee wastewater. The side objectives of the study are:

- To study effect of treatment on coffee wastewater.

- To study the Biochemical Oxygen Demand and Chemical Oxygen Demand parameter in order to evaluate the effectiveness of each treatment.

Methodology:

Research approach

To know which method the most suitable treatment is needed, an analysis on coffee processing wastewater treatment technology can be applied. This analysis included the technology applied either in the lab experiment or tested on pilot plant simulation. Therefore, the data obtained for coffee treatment effluent were processed in the form of tabulation. An analysis on efficiency of coffee wastewater treatment method can be found by comparing each scientific research based on wastewater contaminants limit regulations.

Research Design

The research used qualitative research approaches based on data collection from scientific research paper. Regarding case studies, the research aims to gather an in-depth understanding about treatment method applied to coffee effluent and treatment efficiency via significant result achieved. The data analysed in this research consist of two data. The first study is about the physico-chemical parameter of coffee effluents. The parameter data obtained from literature study for various coffee processing plants around the world. Secondary data, as complementary and supporting for primary data, were obtained through literature study and data from other related institutions and relevant to this research.

Data Collection

Method	Treatment Condition	Initial Parameter	Final result	Reference
Moringa Oleifera seed extract	1. pH = 3 – 7 2. Dose of MOSP = 0	TSS = 163 mg/L COD = 2430	TSS reduction 8.00 – 54.12% COD	[1]

	3. Mixed speed = 200 rpm	– 4 g/L mg/L	reduction 26.02– 100.00%	
(a) Casuarina fruit powder	1. Time = 180 min	COD = 11300 mg/L	COD reduction	[2]
(b) Sorghum stem powder	2. Doses = 4 g/L	N = 4.0 mg/L	99.2%	
(c) Banana Stem powder	3. pH = 7	TSS = 3190 mg/L	N reduction	
	4. size ≤ 0.30 mm		92.7%	
	5. Mixed speed = 300 rpm		TSS reduction 81.0%	
(a) Coagulation-flocculation		COD = 4300 mg/L	a) COD reduction	[3]
(b) Coagulation-flocculation + UV/H ₂ O ₂			67.03 %	
(c) Coagulation-flocculation + UV/O ₃ + UV/H ₂ O ₂ /O ₃			b) COD reduction 86.05%	
			c) COD reduction 87.01 %	
Avocado peel carbon	1. 70 min	COD = 22,000 mg/L	COD Reduction	[4]
	2. 4 g/100 mL	BOD = 12,000 mg/L	98.20 %	
	3. 7		BOD Reduction	
	4. ≤ 0.25 mm		99.18 %	
	5. 800 rpm			
Simple anaerobic batch reactor (ABR)	1. Room temp range (20–23 °C)	BOD ₅ = 5,861.0 COD = 8,079.0 TSS = 2,019.0	BOD ₅ and COD reduction	[5]
	2. pH= 7.0		90 %	
	3. HRT = 70 d		TSS reduction 95 %	
Wetland with aeration and vegetation	1. pH = 7.0		Total nitrogen reduction	[6]
	2. Flow rate = 0.020 m ³ /d		69.03 %	
	3. HRT = 12 d		Total phosphorus reduction	
			72.05 %	
			Total	

			potassium reduction 30.02 %	
UASB and wetland	pH = 5.9 – 6.1	Biological Oxygen Demand (BOD) of up to 20.000 mg/l and a Chemical Oxygen Demand (COD) of up to 50.000 mg/l	BOD reduction 49 - 81% Suspended solids reduction 36 - 70% (depending on initial BOD loadings and retention time)	[7]
a) Coagulation- flocculation	1. Temp 20°C 2. Source radiation MP-y-30	COD = 2070 mg/L	a) Turbidity reduction 56.7% BOD reduction 47.0 % COD reduction 23.8 %	[8]
b) Coagulation- flocculation and Gamma radiation			b) Turbidity reduction 87.5 % BOD reduction 70.0 % COD	

			reduction 32.5 %	
a) Fenton’s oxidation	<ol style="list-style-type: none"> 1. Fenton dose = 2.5 g/L Fe³⁺ + 9.0 g/L H₂O₂ 2. pH 3.0 3. Temp 30°C 		a) COD reduction 55.7%, BOD ₅ reduction 39.7% TOC reduction 51.3%	[9]
b) Coagulation/flocculation	<ol style="list-style-type: none"> 1. pH 10 		b) Turbidity reduction 92%	
c) Fenton’s oxidation and Coagulation /flocculation	<p>Fenton oxidation</p> <ol style="list-style-type: none"> 1. pH10.0 2. Fenton dose = 2.5 g/L Fe³⁺ + 9.0 g/L H₂O₂ <p>C/F</p> <ol style="list-style-type: none"> 3. pH 5.0, 4. Temp 55°C) 		c) TOC reduction 76.2%, COD reduction 76.5% BOD ₅ reduction 66.3%.	
Coagulation and electrooxidation	<ol style="list-style-type: none"> 1. Dose AlCl₃ = 112 mg/L 2. Boron-doped diamond electrode (electrooxidation) 	<p>COD = 2380 mg/L</p> <p>TOC = 757 mg/L</p>	<p>COD reduction 98.03%</p> <p>TOC reduction 96.04%</p>	[10]
Two stage constructed wetland	<p><i>Phragmites karka</i> plant</p> <p>HRT = 3d</p>	<p>TSS = 399.3 mg/L</p> <p>COD = 13,000 mg/L</p>	<p>SS reduction 94%,</p> <p>Colour reduction 79%</p>	[11]

Eichhornia crassipes plant HRT = 4d
pH = 4.4

BOD = 1720 mg/L

COD reduction 95%

Results:

Biochemical Oxygen Demand (BOD and BOD₅)

Based on Table 1 the highest BOD reduction is using biological process to treat the coffee wastewater the reduction could go up to 90 % reduction of BOD. Using UASB or ABR could reduce the BOD value significantly.

Table 1: Biochemical Oxygen Demand (BOD) percentage removal

Technique	Percentage removal	Reference
Fenton's oxidation	BOD ₅ reduction 39.7%	[9]
Fenton's oxidation and Coagulation/flocculation	BOD ₅ reduction 66.3%.	[9]
Coagulation – flocculation	BOD reduction 47.0 %	[8]
Coagulation-flocculation and Gamma radiation	BOD reduction 70.0 %	[8]
UASB and wetland	BOD reduction 49 - 81%	[7]
simple anaerobic batch reactor (ABR)	BOD ₅ and COD reduction 90 %	[4]

Chemical Oxygen Demand (COD)

Based on Table 2 the highest COD reduction occur through adsorption process. Most of nature adsorbent used in treatment has potential to COD value. The next highest reduction shown by constructed wetland which COD value decrease high also. The traditional by using coagulation and flocculation need to be paired with other technique in order to achieve greater result in coffee wastewater COD reduction.

Table 2: Chemical Oxygen Demand (COD) percentage removal

Technique	Percentage removal	Reference
Moringa Oleifera seed extract	COD reduction 26.02 –	[1]

	100.00%	
(a) Casuarina fruit powder	COD reduction 99.2%	[2]
(b) Sorghum stem powder		
(c) Banana Stem powder		
Coagulation-flocculation	COD reduction 67.03 %	[3]
Coagulation - flocculation + UV/H ₂ O ₂	COD reduction 86.05%	[3]
Coagulation-flocculation + UV/O ₃ + UV/H ₂ O ₂ /O ₃	COD reduction 87.01 %	[3]
Avocado peel carbon	COD Reduction 98.20 %	[4]
simple anaerobic batch reactor (ABR)	BOD ₅ and COD reduction 90 %	[5]
Coagulation-flocculation	COD reduction 23.8 %	[8]
Coagulation-flocculation and Gamma radiation	COD reduction 32.5 %	[8]
Fenton's oxidation	COD reduction 55.7%	[9]
Fenton's oxidation and Coagulation/flocculation	COD reduction 76.5%	[9]
Coagulation and electrooxidation	COD reduction 98.03%	[10]
Two stage constructed wetland	COD reduction 95%	[11]

Based on Table 1 and Table 2, the BOD and COD value varied because it depend on the concentration of organic loads content in coffee wastewater. Since most of reviewed paper focused on COD and BOD value in coffee wastewater, the appropriate method considered also based on those criteria. Anaerobic digestion is the most considered process since it shows high BOD and COD reduction and can handle high volume wastewater without producing more waste unlike coagulation-flocculation process.

Conclusion:

Mostly, the implementation of the treatment technologies have certain limitation to be implemented as certain treatment effective on certain condition. It is crucial that alternatives suitable for regions that can be implemented at low cost are critically assessed and prepared. Many treatment considered in this review such as coagulation-flocculation, adsorption, ionizing radiation, advanced oxidation process, anaerobic

digestion, and phytoremediation (wetland) were analysed in this review. All of these solutions have their own drawbacks due to the nature of coffee processing wastewater and technologies limitation. Anaerobic treatment is the most common as the energy derived can be obtained from coffee processing industry. Most of the coffee wastewater treatment plant in the review introduce anaerobic process in their plant to in favor to reduce the cost and show good treatment efficiency. However, due to scientific advancement the chemical methods such as advanced oxidation process, coagulation-flocculation, and adsorption been shown considerations. The characteristics of coffee wastewater is not sufficient for the chemical process as it needs a high cost due to its volume. One of the researches shows that Constructed wetland (phytoremediation) can produced SS reduction 94 %, Colour reduction 79 % COD reduction 95 %. The Chemical Oxygen Demand (COD) reduction showed that phytoremediation is one of the potential method to be applied in coffee wastewater treatment. So, the best alternative solution is the phytoremediation approach since it also able to replace soil nutrients with low costs for the processed.

SIIC11

UNSATURATION DEGREE OF DATED PALM KERNEL OIL AND ITS POTENTIAL AS PRECURSOR FOR EPOXIDATION

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Abstract:

Vegetable oils are triglycerides derived from plants and made up of chains of fatty acids that it can be saturated or unsaturated depending on the number of carbon-carbon double bonds. This research work was aimed to characterized the palm-based oil (fresh palm kernel oil (PKO), dated PKO, oleic acid, fresh palm olein and dated palm olein) on characterizations and to investigate feasibility of dated PKO as precursor for epoxidation and compare its performance with fresh PKO. The epoxidation reaction was completed with formic acid (HCOOH) as oxygen carrier and hydrogen peroxide (H₂O₂) as oxygen donor with 90 minutes of reaction time by using a mol ratio of PKO:HCOOH:H₂O₂ at 1:1:1. The optimum percentage of relative conversion oxirane (%RCO) for fresh PKO and dated PKO was 3.4% and 3.0% respectively was recorded at 50 minutes of reaction time. The ageing of the PKO does not effects the the time of PKO to epoxidized. The iodine value (IV) for fresh and dated PKO was 13.642 g I₂/100g and 12.373 g I₂/100g was recorded the lowest compared to other oils. Thus, the result of these studies indicate that the dated PKO may be a precursor for epoxidation process due to its performance. In order to further expand this study, it is suggested to investigate additional value-added capabilities after ring opening, as epoxides were very active compounds.

Keywords:

Epoxidation, Unsaturation Degree, Palm Kernel Oil, Iodine Value

Introduction:

The oil palm tree has flourished and has steadily grown into a profitable agricultural crop for the production of palm oil in these countries [1]. In the modern era, oil palm plantations will occupy an area of roughly 3.37 million hectares of Malaysian land. In 2015, oil palm plantations in Malaysia were estimated to have occupied a land area of unprecedented 5.64 million hectares [1]. Fresh fruit bundles (FFBs) of the oil palm tree contain two types of oil which is palm oil (PO) extracted from the fruit pulp (mesocarp) and palm kernel oil (PKO) extracted from the seed or kernel. PKO is removed from the kernel or palm fruit seed by mechanical screw pressing or by means of solvent extraction [1].

The kernel oil contains a wide variety of fatty acids that are found as acyl groups in the triacylglycerols of the oil. This palm kernel oil is an impressive source of saturated fatty acids but also includes monounsaturated and polyunsaturated fatty acids [2]. PKO is known to be lauric oil because lauric acid is the main fatty acid in its composition at around 50 per cent. **Error! Reference source not found.** shows the fatty acid composition of palm oil and palm kernel oil [3].

Table 0.1 Fatty acid composition of palm oil and palm kernel oil [3]

Fatty Acid	Palm Oil (PO)	Palm Kernel Oil (PKO)
Caproic acid	-	0.2
Caprylic acid	-	3.3
Capric acid	-	3.5
Lauric acid	0.2	47.8
Myristic acid	1.1	16.3
Palmitic acid	44.0	8.5
Stearic acid	4.5	2.4
Oleic acid	39.2	15.4
Linoleic acid	10.1	2.4
Linolenic acid	0.4	-
Arachidic acid	0.1	0.1

The carbon-carbon double bond of unsaturated fatty acids in palm kernel oil (namely oleic acid and linoleic acid) can be epoxidized in order to produce epoxy functional group or better known as epoxide or oxirane [4]. Epoxidized vegetable oils have been used in a variety of uses such as plasticizers, polyols, lubricants, resins, composites and coatings [5]. Epoxide is a cyclic ether of three ring atoms. It is also known as epoxy ring or oxirane ring. This ring is roughly characterized by a symmetrical triangle, which makes it highly strained and more reactive than other ethers [4].

Fats and oils are inexhaustible assets that can chemically or enzymatically be treated to create materials that can regularly become a replacement for materials derived from petroleum [4]. One of the major reactions that can be used to boost the efficiency of these fats and oils is epoxidation [4]. Epoxidation increases the polarity and consistency of vegetable oils and enhances their compatibility with polymers [6].

Epoxidation of fatty acids is a carbon-carbon double bond reaction with activated oxygen, which results in the incorporation of an oxygen atom, turning the initial double bond into a three-part epoxy ring [6]. Epoxidized vegetable oils can also be used as plasticizers/stabilizers in the polymer industry [6]. Epoxidation of long chain olefins, and unsaturated fatty acid, for example, soybean oil and other plant oils was done on an industrial scale [7].

Various methods have been developed for the epoxidation of vegetable oils such as homogenous catalytic system by percarbocyclic acid, Heterogeneous catalytic system by acidic ion exchange resins (AIERs), Chemoenzymatic epoxidation, and other metal-catalyzed heterogeneous systems as the oxidant and bio-based catalyst [8]. The epoxidation with percarboxylic acids will be the method used for *in-situ*

epoxidation in this research. Epoxidation is a chemical reaction that converts carbon–carbon double bonds into oxirans (epoxides) using a number of oxidizing agents [8].

Due to the high strain of epoxy ring from epoxidation, it is susceptible to various parameter changes. Therefore using the suitable reaction conditions is paramount in the epoxidation in order to achieve high conversion to epoxide and good stability of epoxy ring. The conditions usually used to maximize the epoxidation of vegetable oil are the temperature of the reaction, the mole ratio of the oxygen donor, the mole ratio of the oxygen carrier, and also the type of catalyst used [4].

The research aims to determine the degree of unsaturation of dated palm kernel oil. Iodine value (IV) is the method to determine the degree of unsaturation of the palm kernel oil. Degree of unsaturation is important to identify the different between edible oil such as fresh palm kernel oil and dated palm kernel oil. Previous research said that the unsaturation increase and saturation decrease as dated palm kernel oil become discoloured and fungal-damaged [9]. Microorganisms are known to cause chemical characteristics that lead to deterioration in quality of oils [10]. Once in a while the fungus increases the amount of unsaturated fatty acids in the mouldy seeds which also cause iodine number to increase [11]. Thus, increase the iodine number will increase the unsaturation degree of palm kernel oil.

Research Methodology:

Figure 1 Illustrates the process flow for Iodine Value (IV) determination. IV was determine through titration methods known as wijs methode. 0.2 g of sample was dissolved with 15 ml of cyclohexane-glacial acetic acid mixture and 25 ml of the Wijs solution. The conical flask was then stored in a dark storage for 60 minutes. After 60 minutes, the conical flask was quickly removed from the dark storage and the reaction was quenched by adding 20 ml of KI solution with 100 ml of water. The sample was titrated with 0.1 N sodium thiosulfate under agitation until yellow colour almost disappeared. Then, add 2 ml of starch indicator and continued titration until blue colour disappeared.

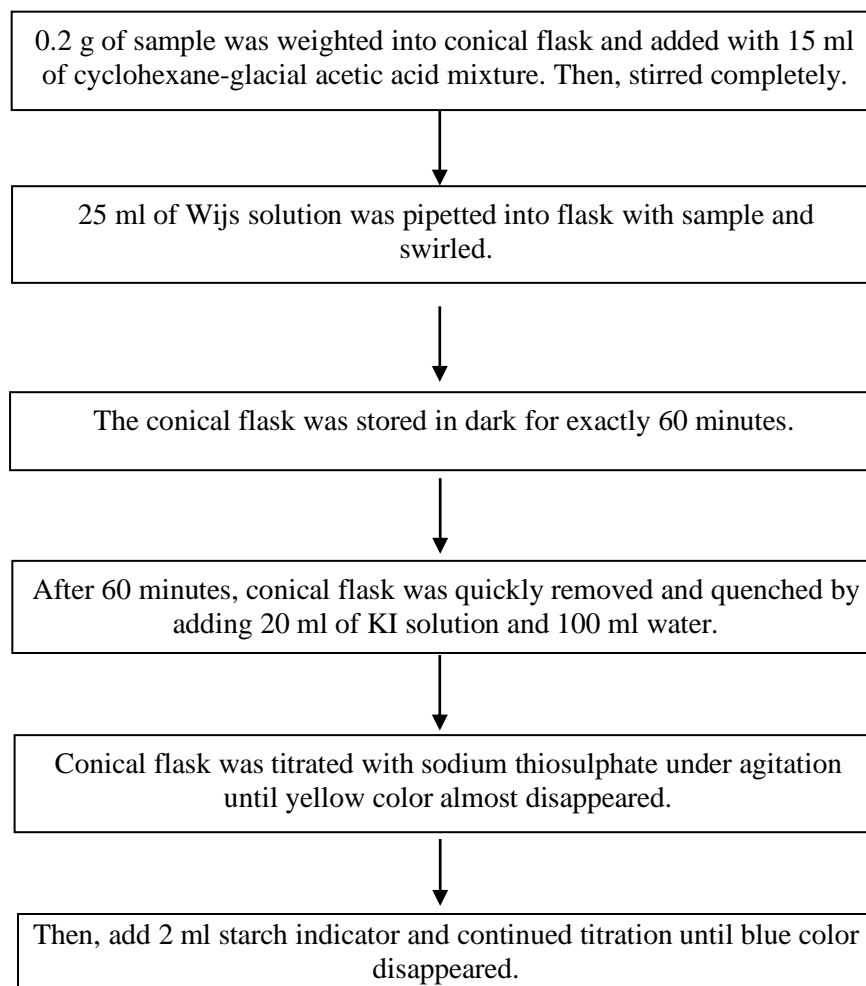


Figure 1 Process Flow of Iodine Value Determination.

Figure 2 Illustrates the process flow for epoxidation. The epoxidation was carried out in 400 ml of beaker with overhead stirrer. 250 g of sample, 33.4 g of formic acid and 0.5 g of sulphuric acid was added simultaneously into the beaker. The mixture of reactants was stirred by overhead stirrer with agitation speed at 500 rpm. Hydrogen peroxide was added at constant flow rate of 4 ml/min using dropper by maintaining the temperature of sample around 40 to 50 °C. 5 ml of sample was taken every 10 minutes using syringe into the sampling bottle. A small amount of sodium sulphate was added immediately into the sample bottle to quench the reaction. Sample taken in sampling bottle was allowed to cool down for 20 minutes.

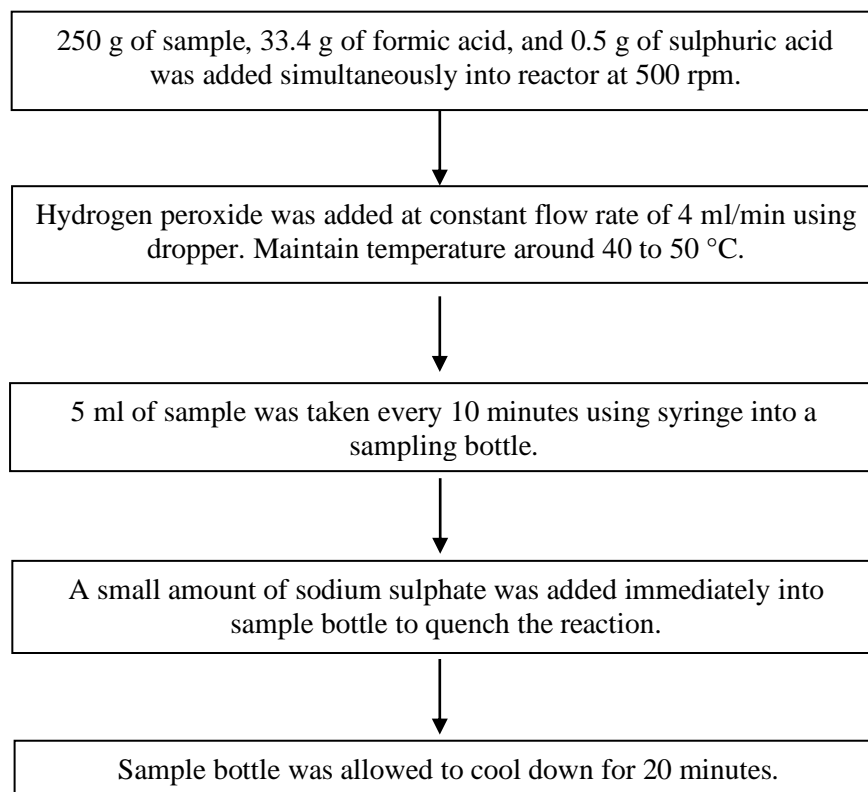


Figure 2 Process Flow of Epoxidation.

Figure 3 Illustrate the process flow for Oxirane Oxygen Content (OOC) Analysis. 0.4 g of sample was weighted into conical flask. Sample was dissolved in 10 ml of acetic acid followed by 5 drops of crystal violet solution. The solution was titrated under agitation with standardized hydrogen bromide solution until bluish green

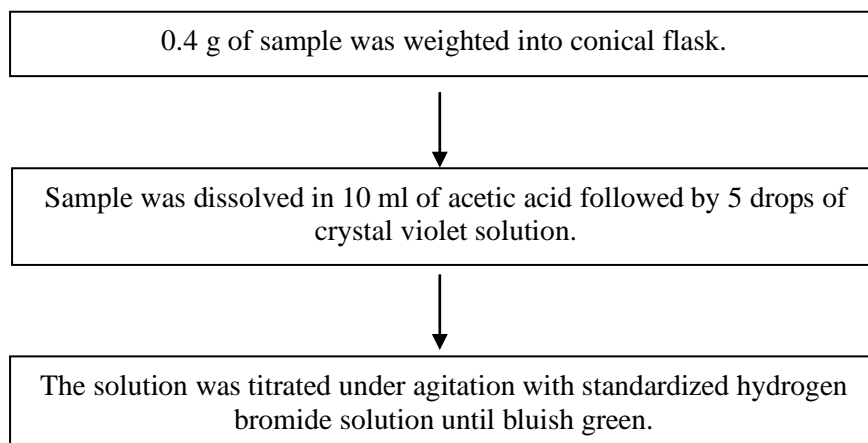


Figure 3 Process Flow of OOC Analysis.

Results:

Table 1 Physicochemical properties of raw materials

Property	Fresh PKO	Date PKO	Oleic Acid (analytical grade)	Fresh palm olein	Date palm olein
Physical appearance (at room T)	White semi-solid	White semi-solid	Clear liquid	Clear liquid	Clear liquid
Iodine value, g I ₂ /100 g (AOCS Official Method Cd Id-92)	13.642	12.373	16.180	17.633	15.863
Density (g/cm ³)	0.851	0.877	0.890	0.881	0.883

Fresh PKO and Dated PKO in form of white semi-solid because there is a precipitation occur. While the other oil have clear liquid appearance because they are purified oil. Iodine value offered insight into the reactivity and degree of unsaturation of fatty acids. The iodine value was a calculation of the number of double carbon bonds. A higher iodine value has resulted in a more reactive and less stable fatty acid content. From

, oleic acid, fresh palm olein and dated palm olein have record a high iodine value which is 16.180 g I₂/100 g, 17.633 g I₂/100 g and 15.863 g I₂/100 g because they are pure unsaturated. From a theoretical point of view, the higher iodine value means a higher chance of iodine ions being bound to the unsaturated carbon chain.

The iodine value of fresh PKO is 13.642 g I₂/100 g and dated PKO is 12.373 g I₂/100 g which is mean the lowest compare to the others sample because they are made of the mixture of saturated and unsaturated fatty acid composition. Dated PKO shows the lower iodine value than fresh PKO due to the consumption of double bonds during the reaction take place [12]. The difference between palm kernel oil and olein oil are due to the fatty acid content [1].

Next, density for all of the material were quite the same because there is no reaction occur on raw materials. However, this is also a significant indicator of the substance. The density of a substance plays a vital role not only in consumer protection, commerce, safety and health, taxes, but also in research and development. It should be remembered that the density increases the molecular weight of the material, which influences its viscosity and the capacity of the substance to flow.

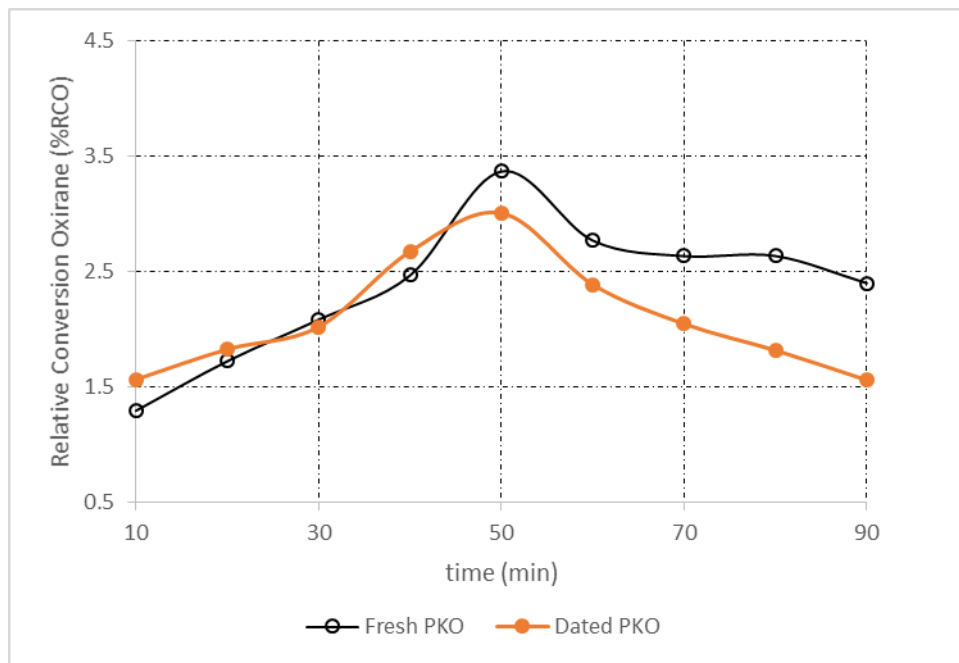


Figure 4 Epoxidation of palm kernel oil

In this experiment, the reaction was carried out at 40° C with agitation speed 500 rpm. Mol ratio of PKO:HCOOH:H₂O₂ (1:1:1) was used for both fresh and dated PKO which prolonged for 90 minutes. Formic acid functions as an autocatalyst in the forming of an oxiran ring. **Error! Reference source not found.** show the epoxidation of fresh and dated palm kernel oil. For the first 20 minutes of the experiment, it has been seen that the oxirane content of dated PKO is higher than that of fresh PKO. After 50 minutes, the graph of oxirane for both PKO starts to decrease due to the degradation or opening of the ring.

The maximum of oxirane value for fresh PKO is 3.4 %RCO while dated PKO is 3.0 %RCO. The more the oxirane value the more of yield of epoxide because oxirane oxygen content indicates the percentage content of epoxide group. Both palm kernel oils had reached the optimal or optimum oxirane content at the same time taken which is at 50 minutes of the experiment. Thus, the ageing of the palm kernel oil does not influence the time for the percentage content of epoxide.

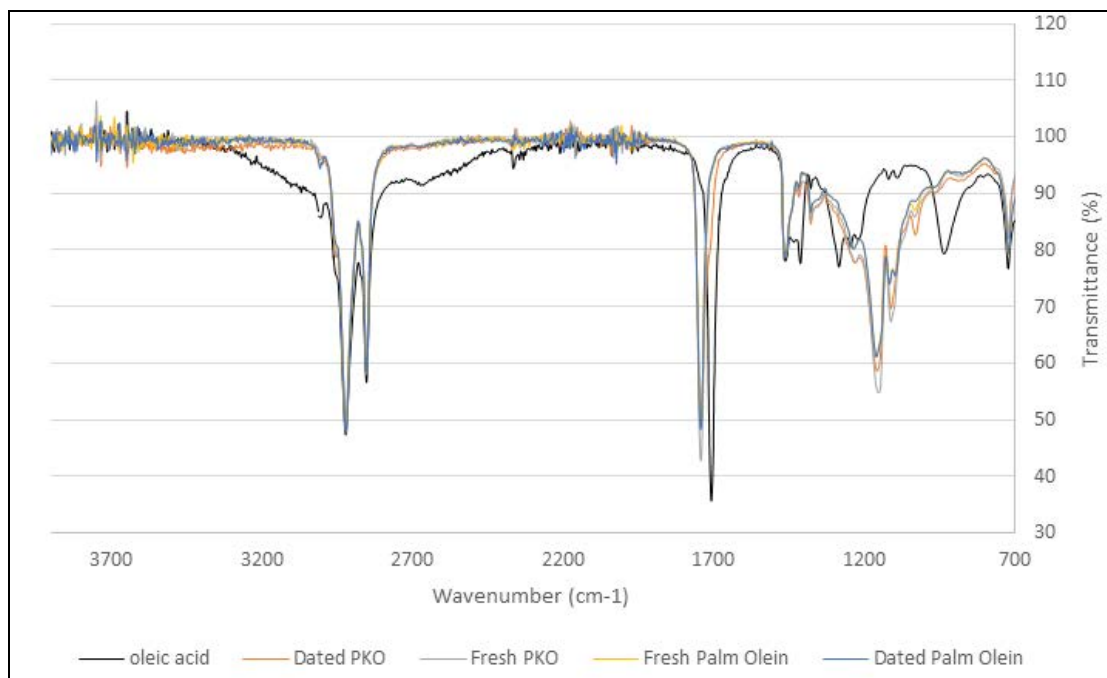


Figure 5 Comparison FTIR Spectra between all types of oil

Table 2 Functional group detected in FTIR Spectra

Functional group	FTIR
C=O stretching	1700
C-H stretching (CH ₂)	2800
C-H stretching (CH ₃)	2950
C=C stretching	3000

FTIR test was applied to the fresh and dated PKO, oleic acid, fresh and dated palm olein in order to identify the present of functional group in the substance. FTIR spectroscopy can be used to determine the molecular composition of the compounds from the absorption bands typical of particular functional groups which are presented as peak spectra [1]. **Error! Reference source not found.** lists the major functional groups foundt in the oil sample used. **Error! Reference source not found.** shown a representative set of infrared spectrum between the raw material in the range of 700 to 3700 cm⁻¹. Based on **Error! Reference source not found.**, overtone streaching vibration peak of C=O for ester was detected at wavenumber 1700 cm⁻¹. At wavenumber 2800 cm⁻¹, C=H streching (CH₂) was appeared while streching vibration peak of C=H (CH₃) aslo being detected at wavenumber 2950 cm⁻¹. Besides, all the substances also had carbon carbon double bond (C=C) streching as recorded in FTIR spectra. This is due to the esterified carbonyl function [1]. It thus demonstrates that all form of oil was appropriate for the epoxidation process.

Conclusion:

In this study, Fresh and dated palm kernel oils was used as raw material for epoxidation with a presence of formic acid as catalyst by using overhead stirrer with 500 rpm about 90 min. Iodine value, density and FTIR were the method used for the oil characterization including on the other oils such as fresh palm olein, dated palm olein and Oleic acid. Experiment for epoxidation has recorded the highest percentage of RCO which is 3.4 % for fresh PKO while dated PKO is at 3.0 %. Both fresh PKO and dated PKO had achieved optimum oxirane value at 50 minutes of the process experiment.

Oleic acid, fresh palm olein and dated palm olein with 16.180 g I₂/100 g, 17.633 g I₂/100 g and 15.863 g I₂/100 g were the highest iodine value compared to the fresh and dated palm kernel oils with 13.642 g I₂/100 g and 12.373 g I₂/100 g respectively. Different edible oils such as dated and fresh PKO, oleic acid, dated and fresh palm olein have various iodine levels according to differing degrees of unsaturation due to the existence of different numbers of double bonds in the carbon atom series [13].

The density of the oil sample does not indicate any difference such as fresh PKO with 0.851 g/cm³, dated PKO with 0.877 g/cm³, oleic acid with 0.890 g/cm³, fresh palm olein with 0.881 g/cm³ and dated palm olein with 0.883 g/cm³. FTIR spectra have shown the major functional group presence in the palm-based oil and the important one is carbon carbon double bonds at wavenumber 3000 cm⁻¹. This oil samples are preferred for epoxidation reactions.

SIIC12

REACTOR: EFFECTS OF DIFFERENT PRESSURE AND TEMPERATURE ANALYSIS USING ANSYS

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Abstract:

There are collective of incident regarding reactor safety that cause fatality either towards humans, environment and towards facilities. This incident has open the world eyes to prioritize safety especially in processing industry involving reactor. Thus, this study will focus on the fixed bed reactor reliability of the effect of pressure and temperature through analysis using ANSYS software in methanol synthesis process.

Keywords:

ANSYS, temperature, pressure, reactor reliability

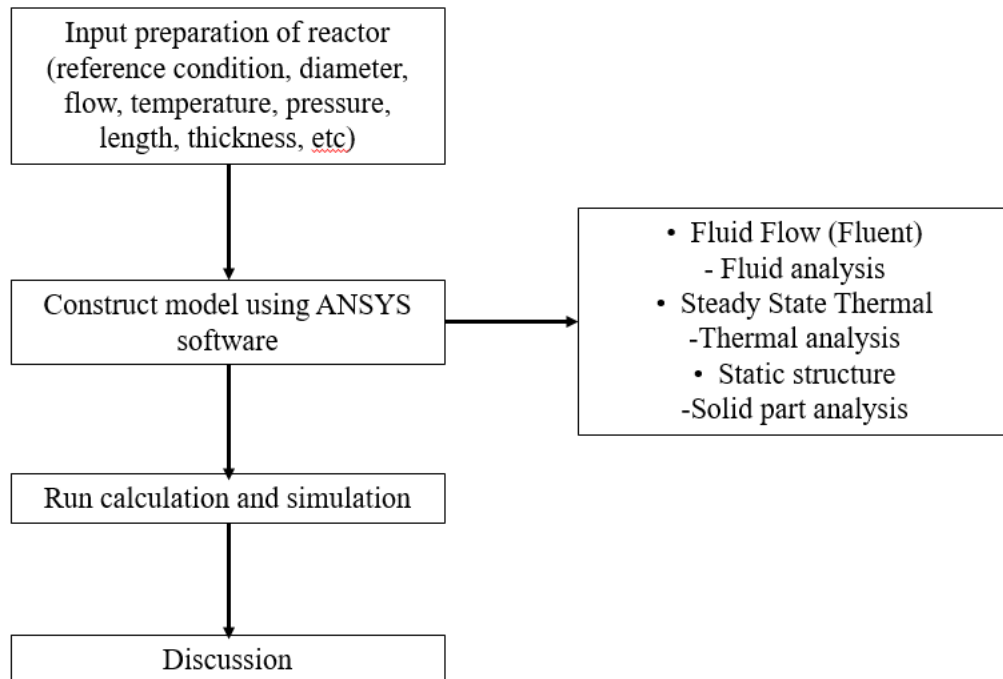
Objective:

- a) To study the effect of pressure on a fixed bed reactor by using ANSYS software.
- b) To investigate the impact of temperature on a fixed bed reactor by using ANSYS software.

Methodology:

The study was conducted by using un-destructive method with the help of ANSYS software. Study focus on the reactor tube with the design taken from the “Analysis of a 2-D model of a packed bed reactor for methanol production by means of CO₂ hydrogenation” paper written by Grazia Leonzio and Pier Ugo Foscolo.

Chart 1: Flowchart of process flow



Result:

Figure 1: Life contour of tube at 498K

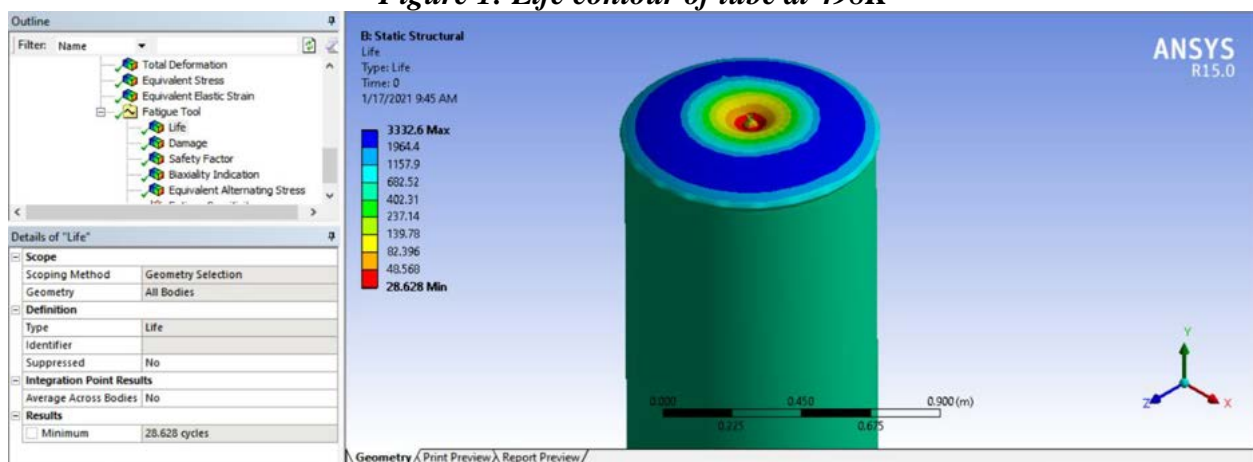
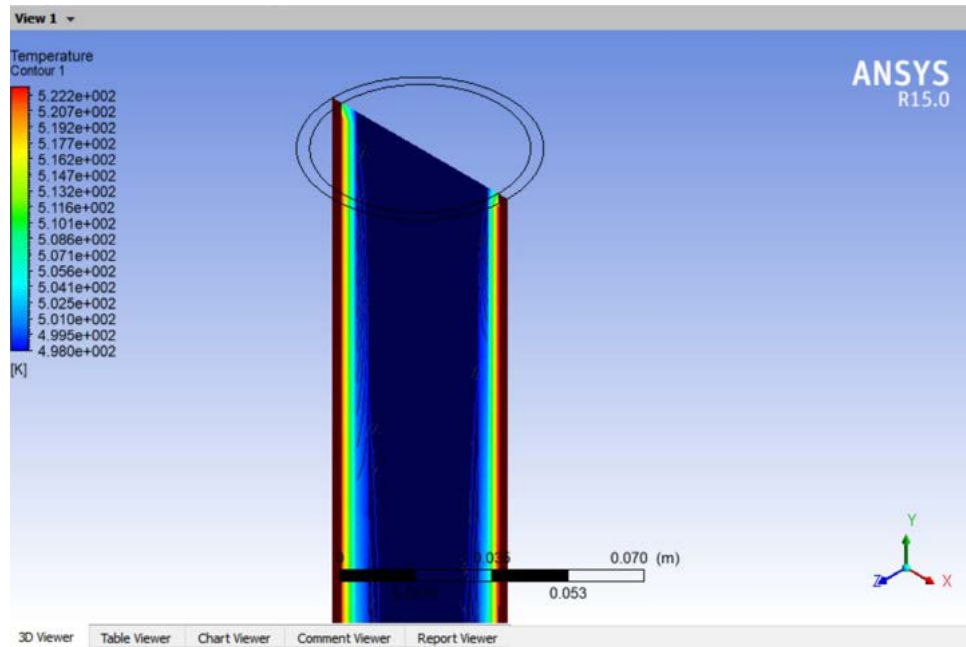


Figure 2: Plane contour of tube at temperature at 498K

**Table 1: Result table**

<i>Pressure (Pa)</i>	<i>Minimum Lifecycle</i>	<i>Temperature (K)</i>	<i>Minimum Lifecycle</i>
525, 000 00 Pa	19	498K	28
529, 000 00 Pa	2	670K	10
530, 000 00 Pa	0	676K	0

Conclusion:

This study aim to understand the effect of pressure and temperature on the reliability of reactor tube in a methanol synthesis process using ANSYS software. The result obtain shows the greater the pressure inlet, the less number of tube cycles. Same goes to the temperature analysis, as the temperature increase, the number of tube cycles decreased. The tube reactor maximum temperature and pressure are determined when the number of cycles reading shows zero, that indicate the point where the tube experience fatal damage such as crack formation. The maximum pressure obtain through the simulation is 530, 000 00 Pa while the maximum temperature where the lifecycle is zero is 676K.

SIIC13

SYNTHESIS AND CHARACTERIZATION OF MIXED OXIDES CATALYST TO PRODUCE FAME

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Abstract:

Biodiesel known chemically as fatty acid methyl esters (FAME) is an alternative to fossil fuels. The process of transforming cooking palm oil into biodiesel is called transesterification reaction. Transesterification is the chemical reaction between a triglyceride and alcohol in the presence of the catalyst, producing a mixture of fatty acid esters and glycerol. Heterogenous catalyst is the preferred catalyst in this research due to the least problem to the overall reaction compared to homogenous catalyst and enzyme. The Mn-Al mixed oxides catalyst was synthesized via sol-gel method at different metal ratio and tested in the transesterification of FAME. The reactions were conducted in a batch reactor at temperature 55°C, methanol to oil molar ratio of 15:1 and catalyst loading of 2wt%. The thermal stability and presence of surface functional group were investigated using thermal gravimetric analysis (TGA) and Fourier-transform infrared spectroscopy (FTIR). The synthesis catalyst is also used for determination of FAME density by Micromeritic Pycnometer model AccuPyc II 1340. The result shows that catalyst with metal ratio 1:0 obtained FAME density of 864.9 kg/m³ which is the closest to the standard palm oil density. However, based on TGA analysis, metal ratio 1:2 has stable weight change at temperature 500 °C with the second closest FAME density of 861.4 kg/m³. Thus, the best catalyst based on this research is metal ratio 1:2 according to TGA analysis and FAME density. Thereby, this research highlights the recent effective investigation in prepare and characterize Mn-Al mixed oxides catalyst.

Keywords:

Biodiesel, Metal Oxide, Fatty Acid Methyl Ester, Catalyst, Transesterification

Objectives:

- To synthesis the Mn-Al mixed oxides catalyst via sol-gel method at difference metal ratio for transesterification of FAME.
- To characterize the Mn-Al mixed oxides catalyst in terms of thermal stability and surface functional group using TGA and FTIR.

Methodology:

Figure 1 illustrates the process flow on the synthesis and characterization of mixed oxides catalyst to produce FAME.

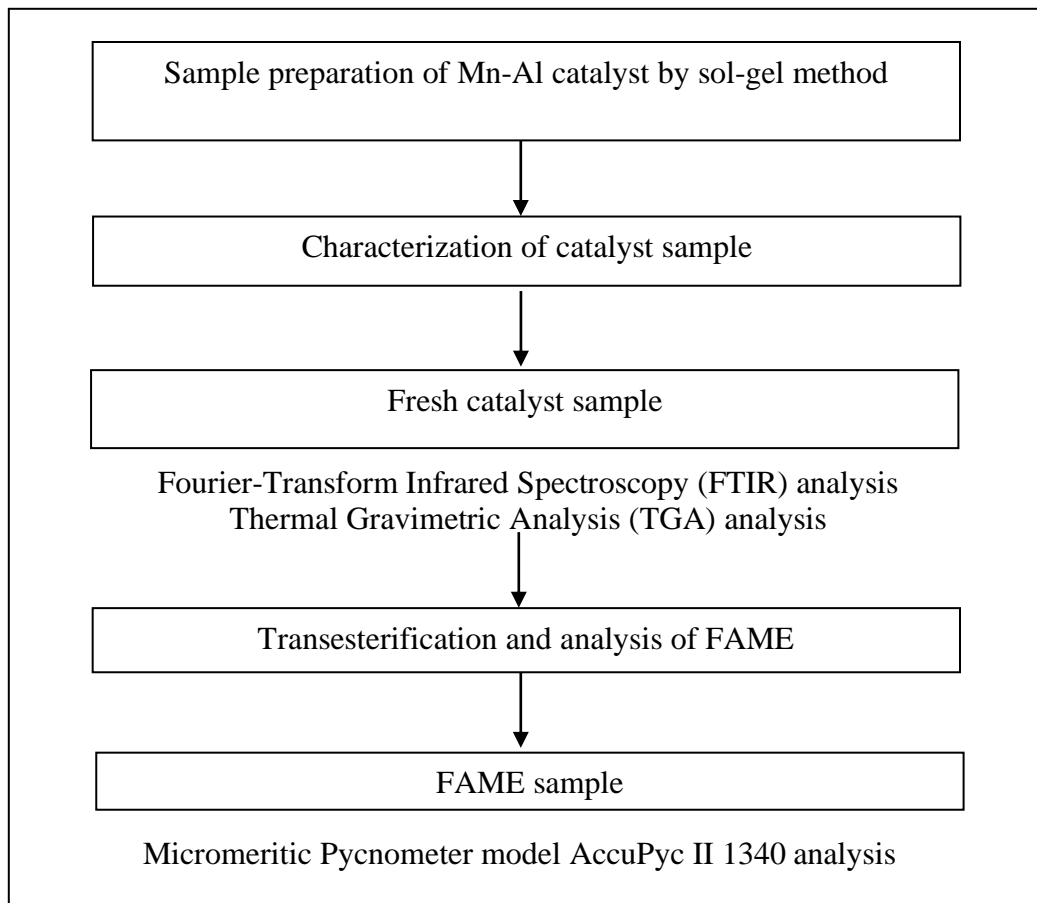


Figure 1 Process flow of project

Results:

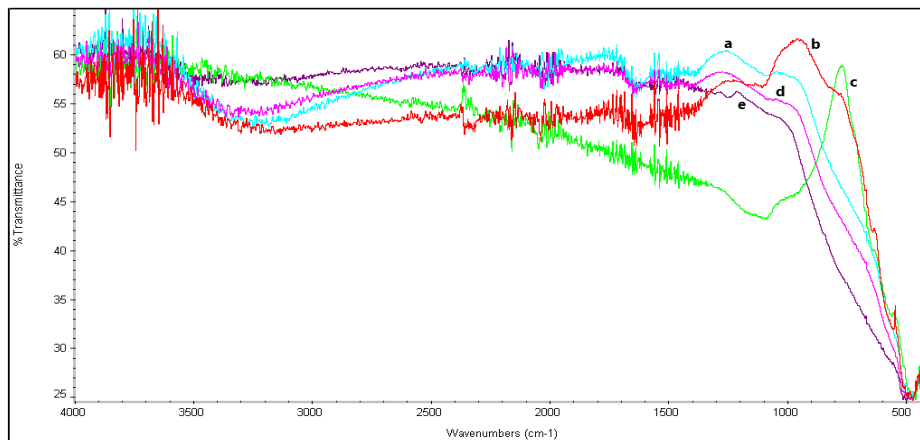


Figure 2 FTIR spectra of metal ratio (a) 1:1 (b) 2:1 (c) 1:0 (d) 1:2 (e) 0:1

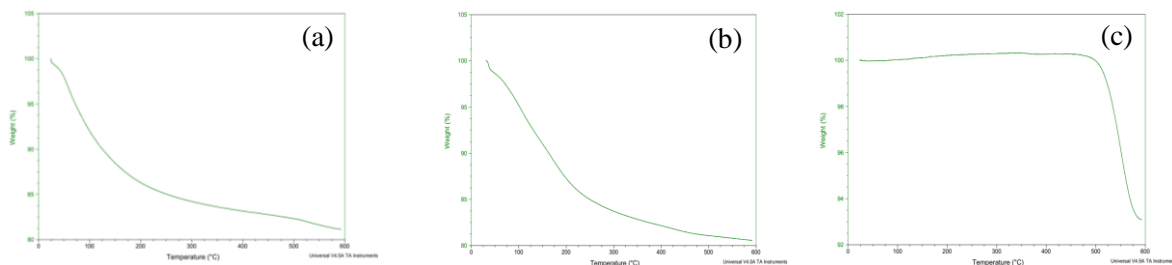


Figure 3 TGA profile of metal ratio (a) 1:2 (b) 1:0 (c) 0:1

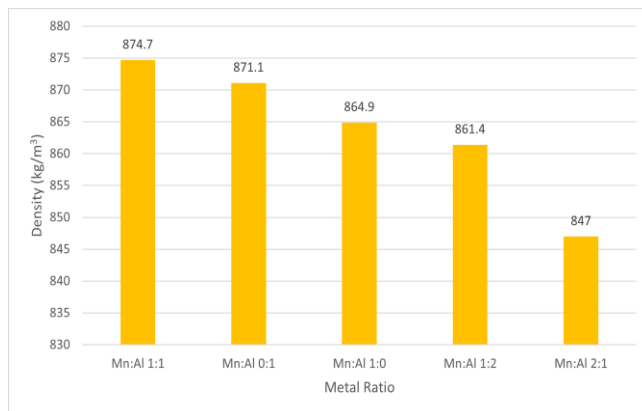


Figure 4 FAME density for different metal ratio of Mn-Al mixed oxides catalyst

Conclusion:

The Mn-Al mixed oxides catalyst with different metal ratio 1:1, 1:0, 0:1, 2:1 and 1:2 successfully prepared by using sol-gel method. The FTIR spectra of different metal ratio catalyst samples in the region of 500-4000 cm⁻¹ are presented in Figure 2. The spectra of the catalysts showed some identical functional groups detected on their surfaces, which revealed a similar pattern. The most obvious are the peaks at 500-600 cm⁻¹ assignable to the stretching vibration of C-l group attached to the surface of the metal. Another prominent peak at 1600-1650 cm⁻¹ can be observed in all samples, which assigned to C=C bending vibrations. However, the peak at the metal ratio of Mn-Al 1:0 is less intensified compared to the other samples. The samples of metal ratio 1:0 has a peak at 1087-1124 cm⁻¹ which indicated C-O stretching vibration. The TGA profiles of metal ratio (a) 1:2, (b) 0:1 and (c) 1:0 was shown in Figure 3. The TGA profile for the Mn-Al catalyst sample metal ratio of (a) 1:2 and (b) 0:1 shows that the weight loss from room temperature to 100 °C due to the evaporation of moisture content, which indicates that the catalyst is hygroscopic. Then, the temperature between 100 °C to 300 °C shows the weight loss due to decomposition of precursors material such as nitrate compound. The weight change is small after 450 °C indicating a stable metal oxide. The TGA profile for catalyst sample of metal ratio (c) 1:0 shows no weight loss from room temperature to 500 °C. The major weight loss was observed at the temperatures between 500 °C to 600 °C. The decomposition was completed at 600 °C after that the weight of the catalyst remained almost constant indicating that 600 °C should be the maximum calcination temperature for the metal ratio. Thus, based on the characterization of the catalyst using TGA shows that a stable catalyst can be achieved using the metal ratio (a) 1:2 and (b) 0:1 and calcination temperature at 500 °C. Figure 4 shows the FAME density obtained from

the transesterification reaction using different metal ratio of Mn-Al mixed oxides catalyst. The transesterification of different metal ratio shows different FAME density. The standard palm oil biodiesel density is 864 kg/m³. The mixed oxide catalyst of metal ratio 1:1 shows the higher FAME density of 874.7 kg/m³ than the standard density. The catalyst of metal ratio 1:0 and 1:2 obtained the FAME density of 864.9 kg/m³ and 861.4 kg/ m³ respectively which is the nearest to the standard palm oil biodiesel density. This indicated that catalyst with metal ratio 1:0 and 1:2 has a good catalytic activity among the synthesis catalysts. Therefore, it can be concluded that based on the research on the synthesis and characterization of mixed oxides catalyst, the best catalyst is metal ratio 1:2 because the density is very close to the standard palm oil biodiesel density. The TGA analysis also shows that this catalyst has good thermal stability.