CERTIFICATION OF APPROVAL

Material Selection for Jatropha Curcas Oil Container

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

(ABDUL RAHMAN BIN RAMBLI)

ABSTRACT

The everlasting demand of diesel and petrol and continuous rise in prices has forces us to search for ecologically sustainable alternative energy source. Jatropha Curcas is identified as one of the most appropriate supply for biodiesel due to the seeds characteristic and advantages that it has.

This study aims to shed light on **selecting the material that can be used to make container for Jatropha Curcas oil**. This study is an experimental study, which objective is to select a suitable material that can be used to create a container for Jatropha Curcas oil.

The methodology used in determining the container is via experiments that investigates the effect of different containers on the oil in terms of chemical composition. The outcome of this study shows that the most suitable material to be used as container for Jatropha Curcas oil is thermostat plastic. However, other material did not cause any significant changes on the oil itself. Thus, the decision to select the material as the container is made solely based on the experiments done in this project.

ACKNOWLEDGEMENT

First and foremost, I thank and praise God, for His guidance and blessing, for without it, I would not have been able to complete my final year project.

A lot has happened during the experimentation and even before that which is when selecting the experiments and determining the course of action for the whole project. I am indebted to a lot of people who has helped in the completion of this project. My deepest gratitude goes to Mrs. Mazlin Idress, my supervisor who has guide me through the whole process and helped in suggesting the suitable approach to the problems encountered during the timeframe of the project.

My salutation would be incomplete without giving credit to UTP, especially the Chemical Engineering Department and Mechanical Engineering Department who has allowed me to use the equipment with the assist of lab technician to guide me through the procedures.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The increase in petroleum oil prices and the environmental concerns regarding the fuels has driven the increase in oil prices worldwide. This is a major cause of concern as the numbers of automotive are increasing every day and due to that, the demand for sustainable biodiesel has increased.

Jatropha Curcas or psychic nut has become a new source of biodiesel. Compared to other vegetable oils like palm oil and sunflower oil, Jatropha Curcas is much cheaper. Jatropha Curcas is resistant to drought and it thrives on any type of soil, grows almost anywhere and also needs minimal input or management According to the European Journal of Scientific Research,

The oil extracts exhibited good physicochemical properties and could be useful as biodiesel, feedstock and industrial application.

However, as the oil is poisonous in nature (Contains Toxalbumin Curcin), it cannot be used for nutritional purposes without detoxification. Jatropha Curcas is also inedible. This makes the nut a very attractive alternative source of fuel as it is a non-food crop.

In this project, the properties of Jatropha oil will be examined as the selection of suitable material to be made as a container is influenced by it. The material should be able to prevent the rapid changes of the oil's properties as it is now. The selection of suitable material will be determined through the experiments that are going to be conducted in the FYP project.

1.2 Problem Statement

As Jatropha oil is an alternative source of fuel and has properties which differs from petroleum based fuels, its reaction to the environment is different. Jatropha oil hydrolyses on storage and long storage of the seeds reduces the viability to below 50% (Kobilke 1989).

This is a problem as in order to be able to use Jatropha oil as an alternative source of fuel, the container that is able to prevent jatropha oil from having rapid change of properties should be made. Normal oil containers are not suitable for usage with Jatropha oil as jatropha oil is vegetable based oil which has different problem compared to petroleum based oil.

Therefore there is a need to select a suitable material to be used to create the container to store Jatropha oil as if it's going to be mainstreamed one day as alternative for oil, the oil will be stored for a long time and the container should be able to maintain the properties of the oil over time.

1.3 Objective and Scope of Study

The objective of the project is:

1) To select a suitable material to be made as the container for Jatropha Curcas oil which can prevent the changes in oil properties and enable longer storage time.

The scope of study includes:

1) Conducting research on the material candidates and its properties.
2) Conducting experiments to see the reaction between Jatropha Curcas oil and the material candidates

1.4 Relevancy and Feasibility of Study

The study is expected to be feasible after much deliberation based on the following:

1) Most of the equipment, tools and materials are readily available at the university labs and only some required ordering and booking thus reduces waiting time.

2) The objective of the project is to propose a suitable material and not to design the container itself thus is a straight forward experimental research and thus should be simple to conduct.

CHAPTER 2

LITERATURE REVIEW

2.1 Jatropha Curcas

Jatropha Curcas is scientifically known as Jatropha Curcas L. It is a non-edible plant that grows mostly in tropical countries like the Philippines. The plant is drought resistant and can be easily planted and propagated. Jatropha is one of the higher yielding oil crop.

It was earlier used for fencing as the seeds are poisonous (contain toxalbumin curcin) to human beings, most animals and birds. The plants can grow on any type of soil.Jatropha curcas is mainly cultivated for extraction of biodiesel and is one of the best sources of biofuels. In studies of various biofuels, one hectare of Jatropha Curcas yields 6-8 MT of seeds . One ton of Jatropha Curcas seeds yields 300kg oil products and 700 kg oil cake . Before Jatropha oil is mixed with diesel, it has transesterified. This results in production of glycerine, and disposal of this glycerine is a problem. In India, jatropha oil is used for powering farm equipment and diesel generator. Refer to figure 1 to see the lifesycle of Jatropha Curcas.

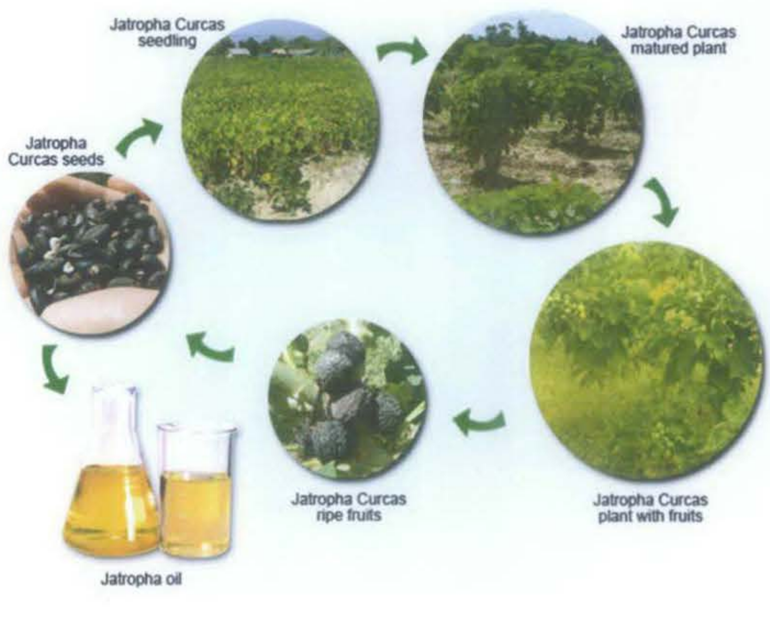

Figure 1: *Lifecycle of Jatropha Curcas*

2.2 Chemical and Physical Properties of Jatropha Curcas Oil

The properties of Jatropha Curcas Oil varies according to the quality of the seed and the storage condition of the seed before the processing them into oil. Table 1 shows some of the chemical and physical properties of Jatropha Curcas Oil.

Property	Jatropha Oil	Property	Jatropha Oil
Flash point	230F/110°C	**Pour point**	8°C
Carbon residue	0.64	**Colour**	4.0
Cetane value	51.0	**Viscosity(cp)(30°C)**	52.6(5.51)
Distillation point (°C)	295°C	**Specific gravity (15°C /4°C)**	0.917/0.923
Kinematics viscosity	50.73cs	**Solidifying point (30°C)**	2.0
Sulphur %	0.13%	**Density (kg/m^3)**	917
Calorific value	9470 kcal/kg	**API Gravity**	22.81

Table 1: *Chemical and Physical Properties of Jatropha Curcas Oil*

2.3 Storing Jatropha Curcas Oil

During storage, oil is likely to react with atmospheric oxygen and other environmental factors, and this may lead to a change in oil quality, particularly increase in FFAs (free fatty acids). The quality of oil may get deteriorated during prolonged storage; generally oxidative and hydrolytic rancidity occurs due to enzymes, air, and moisture.

Jatropha seeds and seed oil quality may get deteriorated on storage due to bacteria, moles, enzymatic degradation, oxidation, and hydrolysis. Therefore, it is important to understand the effect of storage conditions on quality of oil in order to optimize the economically viable storage conditions for storage of oil. Further, following parameters are important for vegetable oil to be used for bio-diesel production.

- Moisture content: The oil must be moisture-free for catalyst-based transesterification process because every molecule of water destroys a molecule of the catalyst, thus decreasing its concentration.

- Free fatty acids: The FFA content should be less than one per cent. It has been observed that the lesser the FFA in oil the better is the bio-diesel recovery. Higher FFA oil can also be used but the bio-diesel recovery will depend upon oil type and amount of sodium hydroxide used.

- odine value: The degree of unsaturated fats can be measured as IV (iodine value). High IV is preferred to lower the cloud point. However, an IV of more than 25 limits the use of oil as neat fuel due to its potential to polymerize.

Jatropha oil is known for its rapid change of properties. Six months storage will not affect the oil content. However, Jatropha seeds are oily and do not store for long. Research on viability of Jatropha seeds oil shows a decrease due to term of storage. Seeds older than 15 months show viability below 50% (Kobilke 1989)

2.4 Material Candidates

Ceramic

Ceramics are classified as inorganic and nonmetallic materials which is used commonly in daily lifestyles. Depending on their method of formation, Ceramics can be dense or lightweight. Typically, they will demonstrate excellent strength and hardness properties; however, they are often brittle in nature. Ceramics are generally made by taking mixtures of clay, earthen elements, powders, and water before shaping them into desired forms.

Glass

Glass is an amorphous solid material. Glasses are typically brittle and optically transparent. Glass is a supercooled liquid, meaning that it is rigid and static but does not change molecularly between melting and solidification into a desired shape. Glass is one of the most versatile subtances on earth. Glass occurs naturally when rocks high in silicates melt at high temperatures and cool before they can form a crystalline structure. When manufactured by humas, glass is a mixture of silica, soda and lime.

Stainless Steel

Stainless Steel is an alloy with a minimum of 10.5% or 11% chrominum content by mass. Stainless steel does not stain, corrode, or rust as easily as ordinary steel, but it is not stain-proof. There are different grades and surface finishes of stainless steel to suit the environment that alloy must endure. Stainless steel differes from carbon steel by the ammount of chromium present. Stainless steel contain sufficient chromium to form a passive film of chromium oxide, which prevents further surface corrosion and blocks corrosion from spreading into the metal's internal structure.

Plastic (Thermoset)

Thermoset is a polymer material that irreversibly cures. The cure may be done through heat (generally above 200 °C (392 °F)), through a chemical reaction (two-part epoxy, for example), or irradiation such as electron beam processing.

Thermoset materials are usually liquid or malleable prior to curing and designed to be molded into their final form, or used as adhesives. Others are solids like that of the molding compound used in semiconductors and integrated circuits (IC's).

According to IUPAC recommendation: A thermosetting polymer is a prepolymer in a soft solid or viscous state that changes irreversibly into an infusible, insoluble polymer network by curing. Curing can be induced by the action of heat or suitable radiation, or both. A cured thermosetting polymer is called a thermoset.

CHAPTER 3

METHODOLOGY

3.1 Parameters Identification

Some of the chemical properties of Jatropha Curcas Oil have been selected as the basis for the experiment. The parameters selected are chosen based on both the availability of equipment and the time constrain. Figure 2 shows the tested parameters for Jatropha Curcas Oil reaction with material candidates experiment.

Parameters	Jatropha Curcas Oil Values
Density (g/mL)	0.914
Kinematic Viscosity at 40°C	53.98
Flash Point	230F/110°C
Carbon Residue	0.64
Calorific Value	9470 kcal/kg
C, H, N, O, S Values	76.11, 10.52, 0, 11.06, 0

Table 2: *Tested Parameters for Jatropha Curcas Oil Reactions with Material Candidates.*

Even though the value of all the parameters stated above are already available in the journals as a standard value, a set of base data for all the parameters will be done through the experiments in order to get the same condition as the other tested sample.

By doing so, the base data will not be influenced by the predetermined parameters in the journal but will be relatively comparable to the rest of the tested material candidates.

3.2 Tools Required and Application of Equipment for Experiment

In this project, different equipment will be used for the experiment to test changes in parameters for the reaction between Jatropha Curcas oil with the material candidates. As there is no equipment that is able to identify different parameters, the listed equipment is chosen as the test bed for the experiment. Table 3 shows the list of parameters and the equipment used to test them.

Parameter	Equipment
Kinematic Viscosity	Kinematic Viscometer
Carbon Residue	Total Organic Carbon Eqp.
Calorific Value	Bomb Calorimeter
C, H, N, O, S	CHN-S Equipment

Table 3: *Equipment used for experiment*

Kinetic Viscometer is a device that is used to determine the kinetic viscosity of liquids. It can also be used as a high accurate constant temperature bath.

Bomb Calorimeter is a type of calorimeter used in measuring the head of combustion of a particular reaction. Basically, a bomb calorimeter consists of a small cup to contain the sample, oxygen, a stainless steel bomb, water, a stirrer, a thermometer, the Dewar (to prevent heat flow from the calorimeter to the surroundings) and ignition circuit connected to the bomb.

As all the equipment are available in UTP, the only thing that needs to be done is to book the equipment for usage and this can be done by contacting all the respective technicians

All the values gathered from the experiments done with equipment will be recorded and the results will be compiled in a table and will be represented in a graphical format.

3.3 Experiment Procedures

Overall Procedure

The following are the proposed testing procedures for the observation of the reaction between the material for the container and Jatropha Curcas oil.

1. 2 sets of container made from different materials are prepared
    a. 4 material candidates are tested which makes 8 containers.
2. Equal amounts of Jatropha oil is placed in each container, around 100ml per container.
3. Each container of oil is tested with the following experiments to get base data for the experiments.
    a. Tested properties and equipment used.
        i. Kinematic viscosity – Kinematic Viscometer
        ii. Calorific Value – Bomb Calorimeter
        iii. C, H, N, S – CHN-S Equipment
    b. The properties will be tested based on the following standard.
        i. Kinematic viscosity – ASTM D445
        ii. Calorific Value – ASTM D240
        iii. C, H, N, S – ASTM D5291
4. After getting the base data for the experiments, the containers are left to their own devices for 2 weeks starting from the first date of experiment aside from when the experiment is redone to get a new data.
    a. Set 1: Left in the lab where the ambiance temperature is maintained at around 24-28°C
    b. Set 2: Left in a room, exposed to the environment (direct sunlight, humidity, etc.)
5. The experiment is redone twice which is after 1 week and after 2 week in order to check for any changes in the condition of the oil.
6. All the data was recorded in tables as well as plotted on graph in order to provide a graphical representation of the experiment done.

Kinematic Viscosity Experiment

1) Around 80ml of crude Jatropha Oil is transferred into a beaker.
2) Spindle / Rotor number 2 is chosen from four choices of spindle size.
    a. Spindle number 1 is used for very low viscous fluid such as saline water.
    b. Spindle number 2 is used for slightly viscous fluid.
3) The speed of rotation for the spindle is set at 100RPM.
4) The device is left for around 10 – 15 minutes to ensure that the bubbles in the oil that forms during the transferring into the beaker disappeared.
    a. The bubbles formed in the oil will affect the results of the experiment.
5) After the bubbles cleared up, the reading is taken after the value shown stabilizes with little or no fluctuations.
6) The experiment is repeated 3 times and average value for kinematic viscosity is calculated.
7) After 1 week, the experiment is repeated.
8) After 2 week, the experiment is repeated.

Figure 2: *Kinematic viscosity experiment using jatropha oil*

Calorific Value Experiment

1) Oxygen Gas Regulator is turned on.
2) Bomb calorimeter unit and refrigerator bath switch is turned on, waited 20 minutes for the equipment to stabilize.
3) Sample is prepared (Weighing below 1.0 gram)
4) Sample is placed into a crucible; a cotton thread is secured with a loop in it on the middle of the ignition wire. The assembly is placed into the decomposition vessel.
5) The machine is activated and when the measurement is complete, remove the decomposition vessel, clean and prepare for the next sample.
6) Each measurement took around 10 minutes to complete.
7) The experiment is done only once for each sample due to the limited usage slots available.
8) After 1 week, the experiment is repeated.
9) After 2 week, the experiment is repeated.

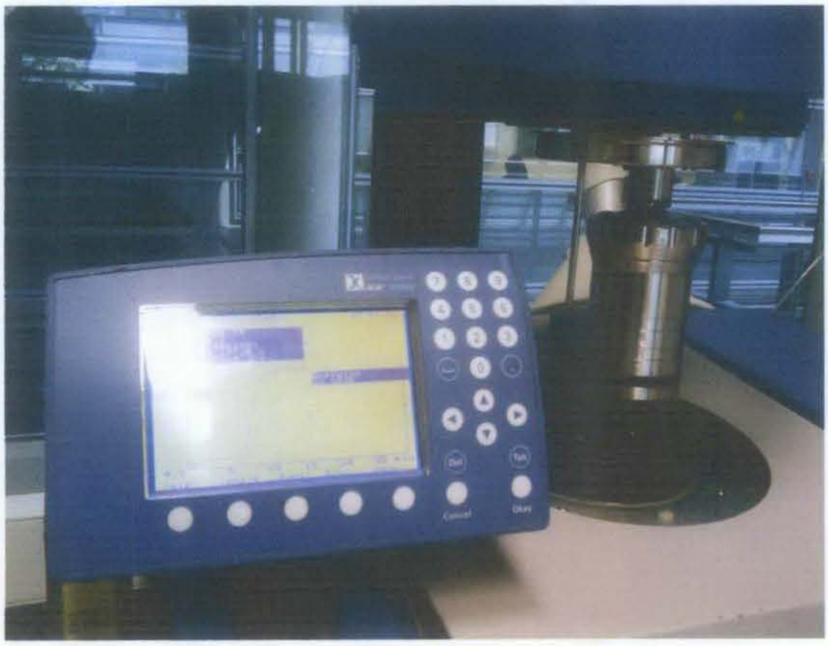

Figure 3: *Bomb calorimeter experiment with jatropha oil*

C, H, N, S Experiment

1) The C, H, N, S equipment is turned on.
2) While waiting for the equipment to stabilize, prepare the materials to be inserted into the equipment.
3) 5 standard samples for C, H, N, S equipment is prepared. The steps to prepare the samples are listed below:-
    a. Silver capsules and sulfamethazine are prepared. Sulfamethazine is a standard chemical compound used by C, H, N, S experiment as a control compound for calibration.
    b. The silver capsules weight are measured beforehand on the scale and the scale are reset to make the silver capsule weight is assumed 0g.
    c. Sulfamethazine is inserted into the silver capsule and the weight of the capsule + sulfamethazine is taken. The weight is ensured to be within 1.5mg – 2.0mg.
    d. The capsule is than carefully resealed by folding the openings to seal sulfamethazine inside the silver capsule.
    e. The weight of the capsule is then retaken to ensure that the weight is still between 1.5mg – 2.0mg.
    f. The process is repeated till all five (5) standard samples are prepared.
4) The Jatropha Oil sample for the experiment is prepared. The procedure to prepare the sample is as shown below.
    a. Tin capsules and Jatropha Oil are prepared. Tin capsules are a standard used by C, H, N, S experiment as a container for experiment samples.
    b. The tin capsules weight are measured beforehand on the scale and the scale are reset to make the silver capsule weight is assumed 0g.
    c. Sorbit is inserted into the tin capsule and the weight of the capsule + Sorbit is reset to 0 mg.
    d. A small droplet of jatropha oil is then placed into the container using a syringe.
    e. The weight of the tin capsule + sorbit + jatropha oil is then measured and the weight shown must be in between 1.5mg – 2.0mg.

f. The capsule is than carefully resealed by folding the openings to seal jatropha oil inside the tin capsule.

g. The weight of the capsule is then retaken to ensure that the weight is still between 1.5mg – 2.0mg.

h. The process is repeated till all eight (8) samples are prepared.

5) The samples are then inserted in the C, N, H, S equipment and the reading is taken at each run.

6) After 1 week, the experiment is repeated.

7) After 2 week, the experiment is repeated.

3.5 Key Milestones

Students play the role of investigator or researcher by performing literature review of the given topic. Assistance and supervision from assigned supervisor is essential in ensuring the project speed is within schedule. Moreover, their guidance in ensuring the given project is within the right path is very crucial in completing this project. The flow chart shown on figure 4 explains the need of steps taken to accomplish this project.

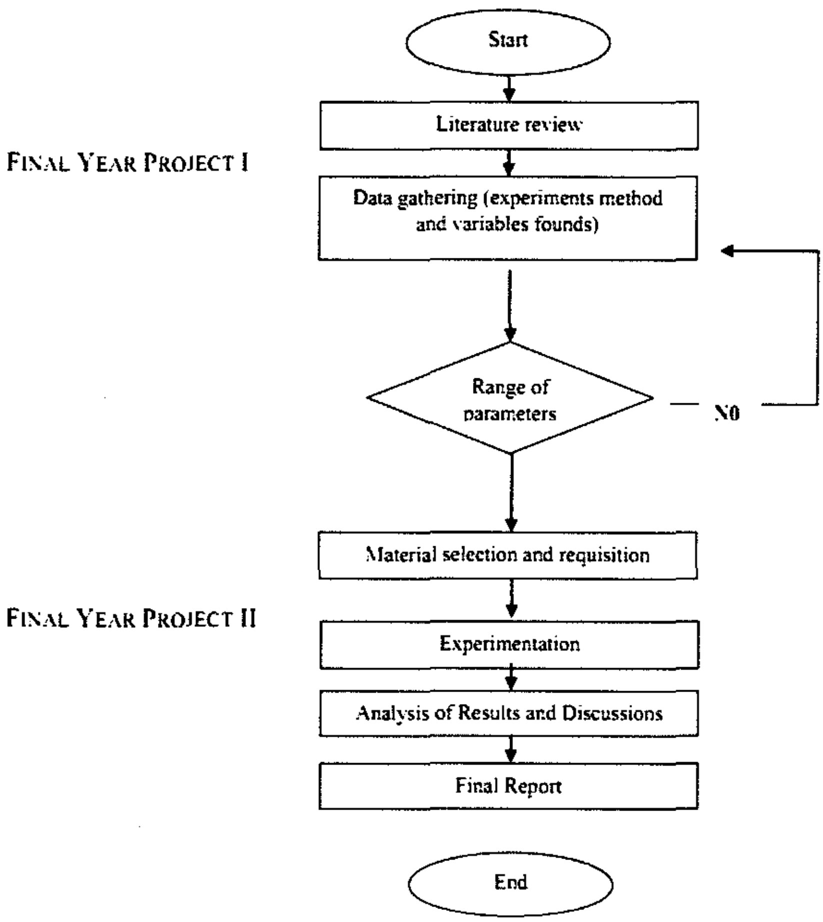

Figure 4: *Flow of work throughout FYP I and FYP II*

The key milestones of the project for FYP 2 are shown on table 4:

No	Activities	Week
1	Buying Material and Chemicals	1-5
2	Experiments	6-10
3	Seminar	10-11
4	Pre SEDEX, Poster	11
5	SEDEX	12
6	Final Report Softbound and Technical Paper Submission	13
7	Oral Presentation	14
8	Final Report Hardbound Submission	14

Table 4: *Key Milestones for FYP II*

3.6 Timeframe Estimation

The schedule of the tasks done during FYP 1 is illustrated in the Gantt chart below:

No.	Activities /Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Lab Work														
2	Progress Report Submission														
3	Lab Work cont....														
4	Pre EDX														
5	Draft Report Submission														
6	Dissertation Submission														
7	Technical Paper Submission														
8	Oral Presentation														
9	Project Dissertation Submission														

Table 5: *Estimation of the timeframe for the project in FYP II*

CHAPTER 4

PROGRESS AND FINDINGS

4.1 Total progress of the project

At the beginning of the experiment, the samples are prepared by splitting a 1 liter sample of Jatropha Curcas Oil into two sets of containers. Each set contains four container made from four different materials which is stainless steel, thermoset plastic, ceramic and glass. Each container contains 100ml of jatropha oil.

The container sets are then placed in two different conditions which are in a lab and in a room with open windows. The reason why this is done is that to test whether exposure to sunlight and humidity will affect the reading and if it does affect, how much the effect will be.

In order to check whether the containers and the change in the sensitivity affected the composition of jatropha oil, the following experiments are done.

1) Kinematic Viscosity Experiment
2) Bomb Calorimeter Experiment
3) C, N, H, S Composition Experiment

The container + oil sets are then left on their own devices for a set period of time before they are being tested again in the experiments to get the data on jatropha oil.

The results of the experiments are then analyzed to determine whether the variables stated above will affect the composition or not. In actuality, there should be other experiments done to test the sensitivity of the material, the oil and the reaction between them. However, due to time constrain and low availability of equipment for experiments, the experiment is not done for this project timeframe.

4.2 Kinematic Viscosity Experiment Analysis

The results from the kinematic viscosity experiment are as shown on table 6. The value from week 0 is 62.8cp and the temperature of the oil during the experiment is 27°C.

	Set 1				Set 2			
	G	C	SS	T	G	C	SS	T
Week 1	62.8	62.7	62.3	63.0	62.6	63.3	63.0	62.7
	63.1	62.8	62.7	62.8	62.7	62.9	63.1	62.7
	62.9	62.7	63.2	63.1	63.2	63.1	62.8	62.8
Average	**62.9**	**62.7**	**62.7**	**63.0**	**62.8**	**63.1**	**63.0**	**62.7**
Week 2	62.9	62.7	63.1	62.5	63.1	63.2	62.5	62.8
	62.8	62.6	63.0	63.4	62.4	63.1	63.3	62.7
	62.9	62.9	62.8	62.9	62.8	62.7	62.7	62.9
Average	**62.9**	**62.7**	**63.0**	**63.0**	**62.8**	**63.0**	**62.8**	**62.8**

Table 6: *Kinematic viscosity experiment results for week 1 and week 2*

Legend:

G – Glass Container   C – Ceramic   SS- Stainless Steel   T-Thermoset Plastic

Based on the results of the kinematic viscosity experiment, we can see that there are little to no changes on the kinematic viscosity of jatropha oil regardless of the material used or the environment exposed at the container.

There might be slight increase or decrease on the reading as shown by the oil kept in stainless steel container (increase by 0.3cp) for set 1 and ceramic (decrease by 0.1cp), stainless steel (decrease by 0.2cp), and thermoset plastic (increase by 0.1cp) in set 2.

There are no visible trends or pattern seen in the changes as per set 1, only stainless steel shows changes in the increment of kinematic viscosity value while on set 2, there are both increment and decrease in the value of kinematic viscosity as shown by ceramic, stainless steel and thermoset plastic.

Comparison for each material in set 1 and 2 is shown in Figure 5, 6, 7 and 8

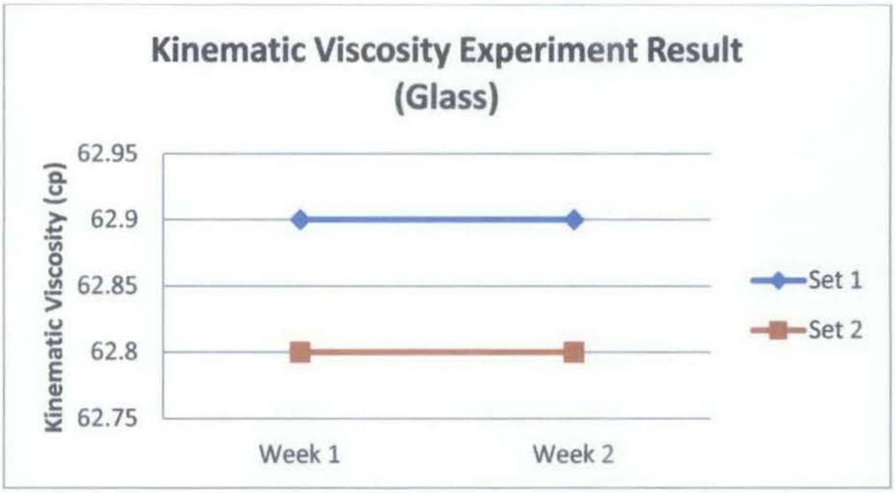

Figure 5: *Kinematic viscosity experiment result for jatropha oil in glass container for the two experiments week period (set 1 and set 2).*

Figure 5 shows that the kinematic viscosity of jatropha oil in class container is not affected by the difference in environment for set 1 and set 2.

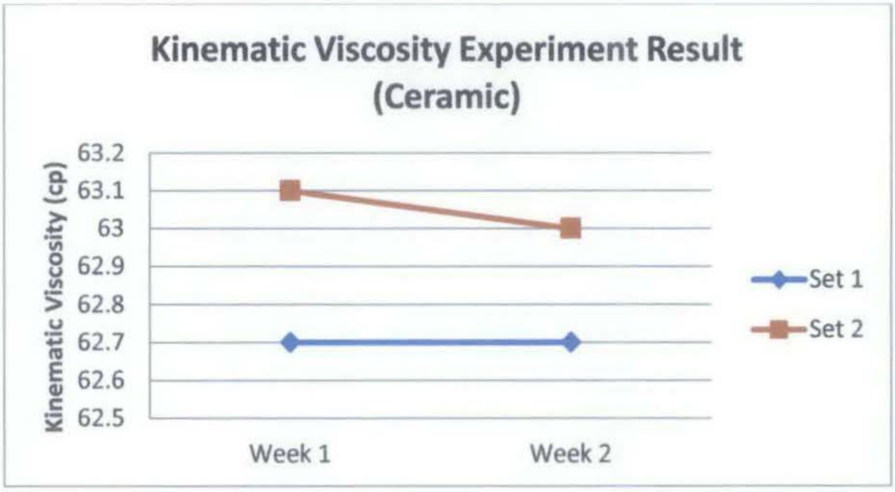

Figure 6: *Kinematic viscosity experiment result for jatropha oil in ceramic container for the two experiments week period (set 1 and set 2).*

Figure 6 shows that the reading from kinematic viscosity experiment for set 1 is the same while there is a slight decrease by 1cp for set 2.

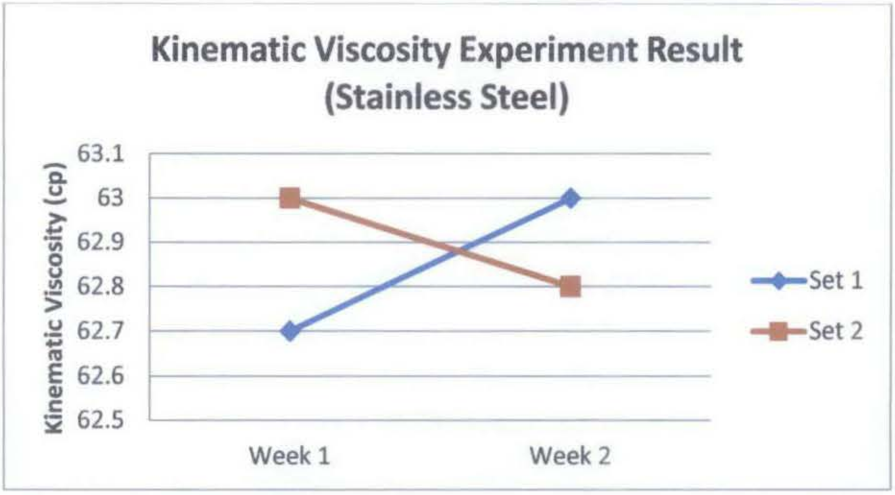

Figure 7: *Kinematic viscosity experiment result for jatropha oil in stainless steel container for the two experiments week period (set 1 and set 2).*

Figure 7 shows that the reading from kinematic viscosity experiment for set 1 increases by 0.3cp while set 2 decreases by 0.2cp.

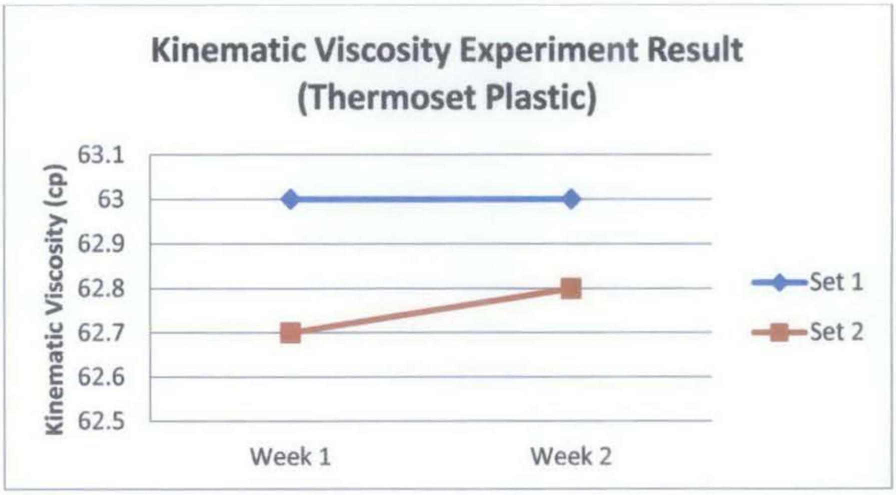

Figure 8: *Kinematic viscosity experiment result for jatropha oil in thermoset plastic container for the two experiments week period (set 1 and set 2).*

Figure 8 shows that the reading from kinematic viscosity experiment for set 1 is the same while there is a slight increase by 0.1cp for set 2.

As shown on the graphs above, the changes in kinematic value only occurs in some of the containers. The differences are also quite small as shown in percentage on table 7. The difference is calculated using the formula:

[(Base cp value – experiment cp value)/Base cp value] x 100 = percentage of difference

Figure 9: *Formula to calculate the percentage of difference in cp value from base jatropha oil and experimented jatropha oil.*

	G s1	G s2	C s1	C s2	SS s1	SS s2	T s1	T s2
W1	0.1592	0.0000	0.1592	0.4777	0.1592	0.3184	0.3184	0.1592
W2	0.1592	0.0000	0.1592	0.3184	0.3184	0.0000	0.3184	0.0000

Table 7: *Percentage of difference in cp value for all material in both set 1 and set 2*

If we take the percentage of difference, there is still no pattern shown that suggests the type of material used to keep jatropha oil affects the kinematic viscosity of jatropha oil. Even though there are slight increment and decrement, the errors in using the equipment in the lab still needs to be taken into consideration.

The slight difference in value is due to the marginal error taken during the experiment. When the experiment is done, the reading is taken when the machine stabilizes and the value shown is constant for a period of time. However, some other outside influences might cause the variation in the reading. For example, small air bubbles that existed in the oil caused variations in the reading of the kinematic viscometer.

4.3 Bomb Calorimeter Experiment Analysis

The results from the bomb calorimeter experiment are as shown on table 8 while the graphical representation of the result is shown on figure 10. The value from week 0 is 39.469 MJ/kg.

	Set 1				Set 2			
	Glass	Ceramic	S. Steel	Thermoset	Glass	Ceramic	S. Steel	Thermoset
Week 1	39.469	39.469	39.469	39.469	39.469	39.469	39.469	39.469
Week 2	39.469	39.469	39.469	39.469	39.469	39.469	39.469	39.469

Table 8: *Bomb calorimeter experiment result for set 1 and set 2*

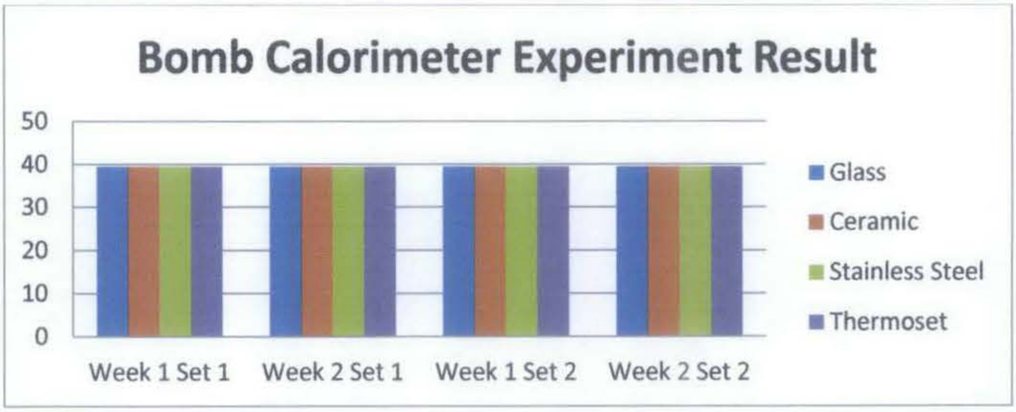

Figure 10: *Graphical analysis of the result from bomb calorimeter experiment.*

There are no changes whatsoever observed on the calorific value of jatropha curcas oil regardless of the type of the container used to keep the oil. This experiment shows that although the oil is kept in containers made from different materials, the heat of combustion and the calorific value of the oil is not affected. The change of environment present in Set 2 also didn't cause any effect on the heat of combustion and the calorific value.

4.4 C, H, N, S Experiment Analysis

The results from the bomb calorimeter experiment are shown on table 9, 10, 11, and 12. The value from week 0 is C=76.58%, N=0.476%, H=11.76%, and S=0%

Glass		Carbon	Nitrogen	Hydrogen	Sulfur
Week 1	**Set 1**	**76.58**	**0.476**	**11.80**	**0.00**
	Set 2	**76.58**	**0.476**	**11.81**	**0.00**
Week 2	**Set 1**	**76.58**	**0.476**	**11.82**	**0.00**
	Set 2	**76.58**	**0.476**	**11.82**	**0.00**

Table 9: *C, H, N, and S content in jatropha oil (kept in glass container) experiment result for set 1 and set 2.*

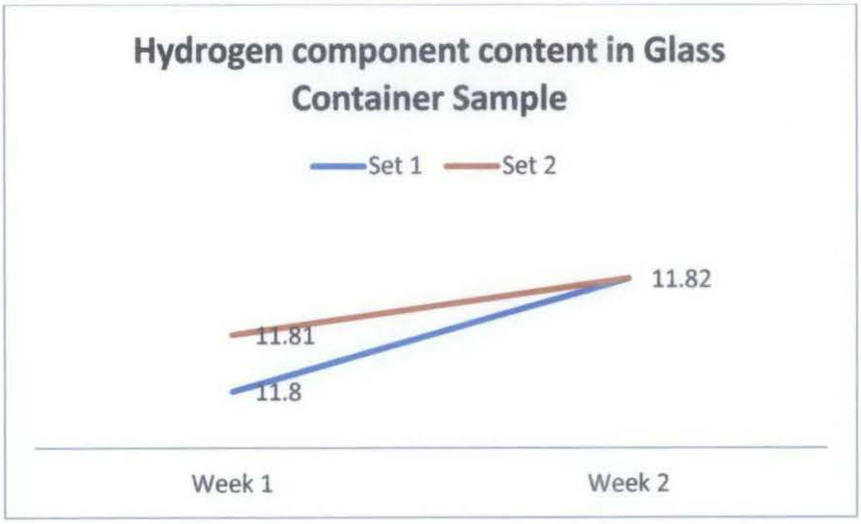

Figure 11: *Graphical analysis of the hydrogen component content in glass container sample for the C, H, N, and S experiment.*

Ceramic		Carbon	Nitrogen	Hydrogen	Sulfur
Week 1	**Set 1**	**76.58**	**0.476**	**11.80**	**0.00**
	Set 2	**76.58**	**0.476**	**11.80**	**0.00**
Week 2	**Set 1**	**76.58**	**0.476**	**11.81**	**0.00**
	Set 2	**76.58**	**0.476**	**11.82**	**0.00**

Table 10: *C, H, N, and S content in jatropha oil (kept in ceramic container) experiment result for set 1 and set 2*

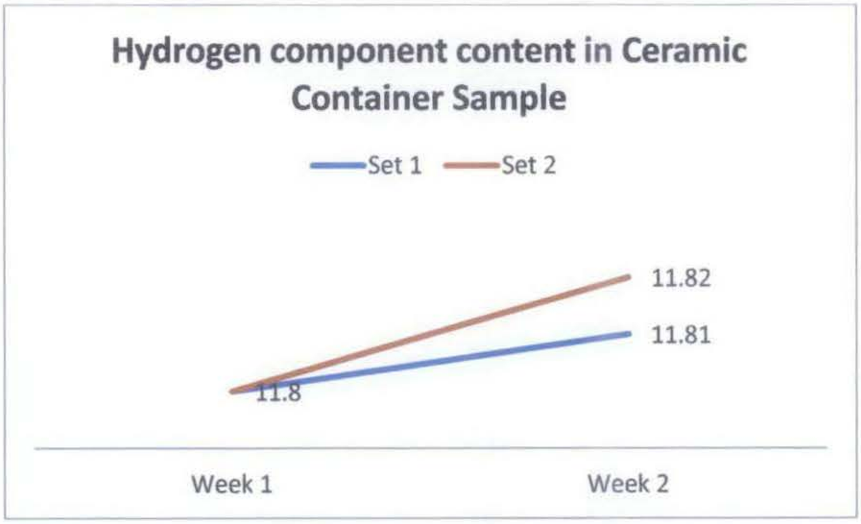

Figure 12: *Graphical analysis of the hydrogen component content in ceramic container sample for the C, H, N, and S experiment.*

Stainless Steel		Carbon	Nitrogen	Hydrogen	Sulfur
Week 1	**Set 1**	**76.58**	**0.476**	**11.80**	**0.00**
	Set 2	**76.58**	**0.476**	**11.80**	**0.00**
Week 2	**Set 1**	**76.58**	**0.476**	**11.82**	**0.00**
	Set 2	**76.58**	**0.476**	**11.82**	**0.00**

Table 11: *C, H, N, and S content in jatropha oil (kept in stainless steel container) experiment result for set 1 and set 2*

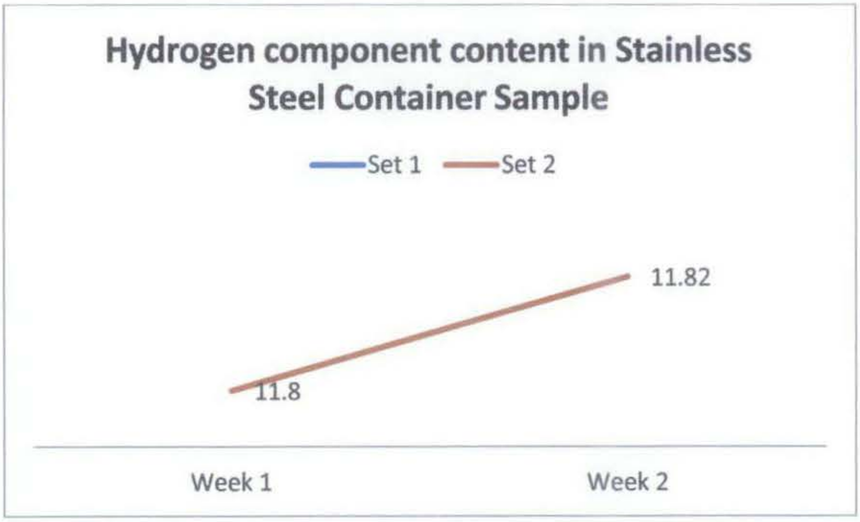

Figure 13: *Graphical analysis of the hydrogen component content in stainless steel container sample for the C, H, N, and S experiment.*

Thermoset Plastic		Carbon	Nitrogen	Hydrogen	Sulfur
Week 1	**Set 1**	**76.58**	**0.476**	**11.78**	**0.00**
	Set 2	**76.58**	**0.476**	**11.78**	**0.00**
Week 2	**Set 1**	**76.58**	**0.476**	**11.79**	**0.00**
	Set 2	**76.58**	**0.476**	**11.79**	**0.00**

Table 12: *C, H, N, and S content in jatropha oil (kept in thermoset plastic container) experiment result for set 1 and set 2*

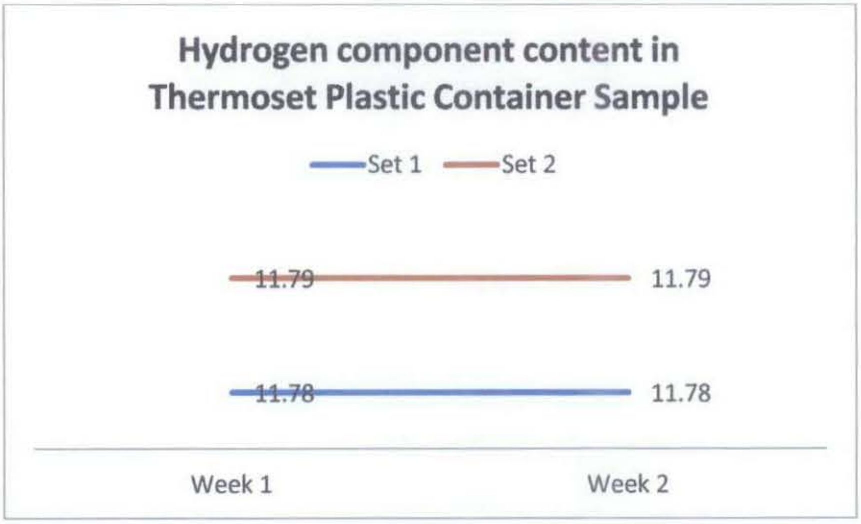

Figure 11: *Graphical analysis of the hydrogen component content in thermoset plastic container sample for the C, H, N, and S experiment.*

This experiment is done to measure any changes on the composition of the sample which is the oil. When the results on the four oil samples in different containers is analyzed, it is discovered that only the oil sample kept in thermoset plastic container didn't have any changes in its composition. Compared to other oil samples, they had slight changes in the hydrogen value especially those in Set 2.

The reason on why the hydrogen value changes is highly because the container themselves has gaps that enables air circulation and moisture to enter the container and form some sort of moisture layer on top of the oil.

When the experiment is done, only a tiny droplet is used to test the C, H, N, S content of the sample. The sample might be contaminated by moisture and other impurities that cause the value of hydrogen to change. The machine used to calculate the C, H, N, S value of a sample calculates the value of the sample placed inside the machine regardless of the type of sample or whether it is hydrocarbon or not. Due to that, the possibility of increase in hydrogen content of the sample, not the jatropha oil as a whole, is there.

As only the thermoset plastic container is tightly sealed via screw cap, the probability of constant airflow and moisture invasion is much lesser compared to other containers.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The aim of this project is to identify the suitable material candidate to be used as a storage container for Jatropha Curcas oil. This is achieved by comparing the results of the experiment which is the reactions between the oil and the material candidates.

The type of material used to store the oil didn't really give any effect on the oil whatsoever. The material chosen according to the result of the experiment, thermoset plastic, is chosen simply because the jatropha oil sample kept in the container made from thermoset plastic has the least change in its properties.

Because of that, other factor aside from the reaction between the oil and the containers needs to be tested and added as the criteria selection for the container.

Factors such as easiness of storage, movement of container and the durability of the container will affect the storage process of jatropha curcas oil. However, due to various restrictions and time constrain, some of the experiments are not done and therefore placed under future recommendations.

5.2 Recommendation

For future works on the project of choosing the material to be made as jatropha curcas oil container, the following recommendations are selected as the next step in the project.

1. Design the container and fabricate identical container for each material.
    a. This recommendation is based on the difference in the design of the container might be the actual cause of the difference in the results and not because of the material itself.
    b. Due to that, in order to rule out the container shape and design variable, similar container design and fabricated using each material selected for the material selection need to be done.
    c. Due to the time constrain and lack of knowledge in using AutoCAD (not enough time to learn the program and be good enough to design containers), the fabrication is not done during the length of the project as the equipment in UTP used for fabrication requires input from AutoCAD.

2. Test the material individually for both chemical and physical properties.
    a. During the length of the project, the container used for the material selection is store bought and not fabricated from scratch. Due to that, some of the properties of the material might not be the same as raw product.
    b. By testing the material individually for both chemical and physical properties, the following factors can be covered.
        i. Easiness of storage and moving the container
        ii. Durability of the container
        iii. Reaction of the container to different sensitivity (Heat/Cold)

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