UNIVERSITY OF NAIROBI

BIOFUEL PRODUCTION USING NON FOOD OIL SEEDS

AND EVALUATION OF THE OILS WITH BLENDS OF FOSSIL FUELS (PARRAFFIN AND DIESEL).

(CHEMISTRY PROJECT)

MUTUA, EMMANUEL MWONGA

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RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE POSTGRADUATE DIPLOMA IN EDUCATION OF THE UNIVERSITY OF NAIROBI

AUGUST 2013

DECLARATION AND RECOMMENDATIONS

This research project report is my original work and has not been presented for the award of a degree in this or any other University.

Signature…………………………………………………….. Date……………………………………………………..

MUTUA, EMMANUEL MWONGA

RECOMMENDATION

This research project has been submitted for examination with our approval as University supervisors.

Signature……………………………………………………… Date………………………………………………………

MS IMMACULATE ALALA

Lecturer, University of Nairobi.

Acknowledgment

The financial support for biodiesel project by Akithii Girls Secondary, Isiolo private lab is highly appreciated. The project confined to the identification, production and characterization of biodiesel from plants based resources .I also wish to appreciate the guidance of Ms Immaculate Alala (Lecturer University of Nairobi) throughout this project.

ABSTRACT:

Environmental pollution and diminishing supply of fossil fuels are the key factors leading to search for the alternative sources of energy. Today, 86% of the world energy consumption and almost 100% of the energy needed in the transportation sector is met by fossil fuels (Dorian et al., 2006). Since the world's accessible oil reservoirs are gradually depleting, it is important to develop suitable long-term strategies based on utilization of renewable fuel that would gradually substitute the declining fossil fuel production. In addition, the production and consumption of fossil fuels have caused the environmental damage by increasing the CO2 concentration in the atmosphere (Westermann et al., 2007).

Currently the most often-used type of biodiesel fuel is vegetable oil fatty acid methyl esters produced by transesterification of high quality vegetable oil by methanol. Biodiesel derived from vegetable oil and animal fats is being used in USA and Europe to reduce air pollution and dependency on fossil fuel. In USA and Europe, their surplus edible oils like soybean oil, Sunflower oil and rapeseed oil are being used as feed stock for the production of biodiesel (Ramadhs et al., 2004; Sarin and Sharma, 2007).Since more than 95% of the biodiesel is synthesized from edible oil, there are many claims that a lot of problems may arise. By converting edible oils into biodiesel, food resources are actually being converted into automotive fuels. It is believed that large-scale production of biodiesel from edible oils may bring global imbalance to the food supply and demand market. Recently, environmentalists have started to debate on the negative impact of biodiesel production from edible oil (Butler, 2006). They claimed that the expansion of oil crop plantations for biodiesel production on a large scale may increase deforestation in countries like Malaysia, Indonesia and Brazil. Furthermore, the line between food and fuel economies is blurred as both of the fields are competing for the same oil resources. In other words, biodiesel is competing limited land availability with food industry for plantation of oil crops. Arable land that would otherwise have been used to grow food would instead be used to grow fuel (Anonymous, 2004). In fact, this trend is already being observed in Kenya. There has been significant expansion in the plantation of oil crops for biodiesel in the past few years in order to fulfil the continuous increasing demand of biodiesel.Biofuels or liquid fuels are derived from plant materials. Their introduction into the market was influenced by the oil spikes in prices noticed on fossil fuels and the increased carbon emissions into the atmosphere depleting the ozone layer a phenomenon described as global warming.

The first generation biofuel introduced was bioethanol which is an alcohol made from fermenting sugar components of plant materials for example sugarcane; other biofuels include biodiesel which were made from vegetable oils and animal fats.

The global dilemma about biofuel production is that they rely mostly on plant materials which form the basic human resource for food which keeps them in their optimum condition, these plants include; maize, sugarcane and sunflower.

In this research we try to introduce nonfood oil seeds for biofuel production to ease the pressure on human food oil seeds. It has been noted that some existing non food oil seeds have the capacity to act as biofuels when blended with other biofuels like ethanol and paraffin. The aim of this research is to extract oil from this seeds and determines their physiochemical capability to act as biofuels.

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CHAPTER 1

BIOFUEL PRODUCTION USING NON FOOD OIL SEEDS AND EVALUATION OF THE OILS WITH BLENDS OF FOSSIL FUELS.

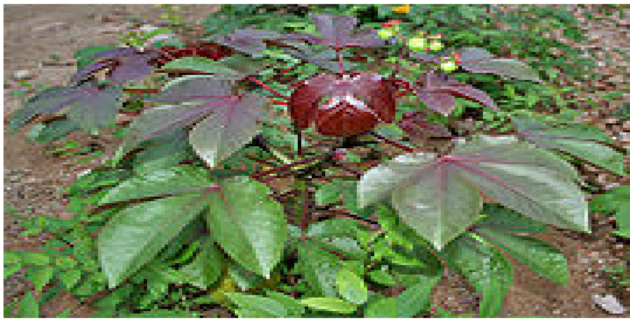
INTRODUCTION:

Biofuels are liquid fuels that are derived from plants, the first generation biofuels are made from sugar, starch, vegetable oil and animal fats using the modern conventional technology. The basic feed stocks consumed by humans but used for the production of biofuels include; ***wheat*** which yields starch that is fermented into bioethanol, ***sunflower*** seeds which are pressed to yield vegetable oil that are used to yield biodiesel, others include maize and soybeans. This feed stocks are meant be utilized into the human food chain but due to growing global population has led to their producing biofuels which is seriously diverting food from the human food chain leading to food shortages price rises on food supplies.

These has led to devising new and modern methods to yield biofuels from non food oil seeds to divert attention from the human food chain and intern curb the arising food shortages of human feedstocks.This non food oil seeds are locally available and if found viable enough to produce biofuels will empower the farmer biologically and economically. These non food oil seeds include; ***cottonseeds, jatropha.etc***

Extensive work has been done on the transesterification of non edible oils; however, no significant work has been done on the optimization, oil characterization and fuel analysis of most of the non edible oil seeds. An optimization study on biodiesel production was done in detail with one-step alkali transesterification process along with the fuel property analysis of these oils and their blends






STATEMENT OF THE PROBLEM

The global dilemma about bio-fuel production is that they rely mostly on plant materials which form the basic human resource for food which keeps them in their optimum condition, these plants include; maize, sugarcane and sunflower.

In this research we try to introduce nonfood oil seeds for bio-fuel production to ease the pressure on human food oil seeds. It has been noted that some existing non food oil seeds have the capacity to act as bio-fuels when blended with other bio-fuels like ethanol, diesel and paraffin. The aim of this research is to extract oil from this seeds and blend them with fossil fuels and determine their burning capability.

RESEARCH OBJECTIVES;

In establishing biofuel production using non food oil seeds the below stated objectives will be effectively met;

- To extract bio-fuels from **Jatropha seeds** and **Cotton seeds** and blend with **paraffin** and **diesel** and determine its burning capability.

- To create an alternative source of bio-fuel in non food oil seeds to ease the competition on human consumed foods.

MERITS AND LIMITATIONS

MERITS

- Extraction of this oils involves a cheap and all to do experiment
- A small portion of this seeds has a substantial amount of oil hence giving a high % yield
- In Meru, Isiolo, Mwea, Kitui and their environs this seeds are locally available and grow naturally which has a positive impact on their accessibility
- If the seed bearing trees are planted in large scale they will have other economic applications including preserving our ecosystem
- Utilization of this oil will create substantial competition with fossil fuels leading to reduced prices.
- The oil blends fully support burning and their bulk is sufficient

LIMITATIONS

- Non food oil seeds are not planted in our farms since their economic value has not been fully exploited hence our acquisition of the seeds was a problem
- Some of the equipment used in this project could be expensive for large scale production of oils.

PRECAUTIONS

Hexane is very volatile and could cause fire if mishandled.

SIGNIFICANCE OF THE STUDY;

In the industrialized economies the pressure on fuel is growing day to day and the growing global population is not helping the situation either because every human resource requires fuel for example transport(cars,buses,motorbikes) all this need fuel to power their engines, all the machines in the industrial sector need fuel to power their functionality hence the pressure on fossil fuels has grown and the crude resource is slowly being depleted and all this has led to increased world oil prices per barrel which has diverse effect on the economy.

This led to the invention of biofuel technology like the production of bioalcohols and biodiesels from plant materials to substitute the fossil fuels. The dilemma here is that this technology relies mostly on the human food chain for the biofuel production and this is a threat to food security since there is fuel vs. food competition.(Wallace 2009)

This project is aimed at devising methods of extracting biofuel from non food oil seeds to meet the already mentioned objectives.

CHAPTER 2

LITERATURE REVIEW:

BIOFUELS

These are liquid fuels derived from plant materials. Their entering to the market driven factors include; oil price spikes and need for increased food security. They are made from sugar, starch, vegetable oil and animal fats.

BIOALCOHOLS

These are biofuels made from fermenting sugar components of plants mostly sugar and starch crops.

Ethanol; This is the most common biofuel worldwide and mostly used in Brazil. The alcohol fuel is produced by fermentation of sugars derived from wheat, corn sugar beets, sugarcane, molasses and any sugar or starch that alcoholic beverages can be made from like potato and fruit waste.

Method: Ethanol production methods used are enzyme digestion to release sugars from stored starches, fermentation of sugars is then done followed by distillation and drying. The distillation process requires significant energy input of heat like natural gases (fossil fuel) also the waste left can be pressed and used for sustainability.

Ethanol can be used in petrol engine in replacement gasoline or it can be mixed with gasoline to any percentage. Ethanol has smaller energy density the gasoline which means it takes more fuel to produce the same amount of work. An advantage of ethanol is that it has higher octane rating than ethanol free gasoline available at roadside gas stations which allows an increase of an engines compression ratio for increased thermal efficiency; other alcohols include butanol produced by hijacking the E.coli amino acid metabolism.(Chemistry logic 1995)

BIODIESEL

They are produced from oils fats using transesterification and are similar to fossil diesel. Its chemical name is fatty acid methyl ester (FAME).

Method: Oils are mixed with sodium hydroxide and methanol and the chemical reaction produces biodiesel (FAME) and glycerol. One part glycerol is produced for every 10 parts biodiesel. Feed stocks for biodiesel include:animalfats,vegetableoils,soy,rapeseed,jatropha,mahua,mustard,flax,sunflower,palmoil,hemp,field pennycress and algae. Pure biodiesel (bloo) is the lowest emissions diesel fuel. Biodiesel can be used in any diesel engine when mixed with mineral diesel.

Other biofuels are made from vegetable oil, bioesters, biogas production, syngas, solid biofuels (charcoal), wood, sawdust and dried manure. The above described mostly rely on human food chain feed stocks and are referred to as first generation biofuels.(Raymond 1996)

SECOND GENERATION BIOFUELS.

These are biofuels developed from the non food crops. These include waste biomass of wheat, corn, wood and biomass crops for example miscanthus.Cellulosic ethanol production uses nonfood crops and does not divert food away from animal or human food chain.Lignocelluloses are the woody structural material of plants.The production of some biofuels e.g. ethanol from cellulosic material is mostly hard since the cellulose has to be digested first by enzymatic material to yield the glucose fermentation.Other biofuel production may be from algae and helioculture which removes carbon dioxide fro the air as a feedstock for the fuel.

Among the various issues with biofuel production include: the effect of moderating fuel prices, the food vs. fuel debate, carbon emission levels, sustainable biofuel production, deforestation and soil erosion, impact on water resources, poverty reduction potential, biofuel prices, energy balance, efficiency and centralized versus decentralized production models. These are some of the issues that have led to the development of this project.

PROPERTIES OF FUELS:

HEATING VALUE/CALORIFIC VALUE

The calorific value of a substance be it food or fuel is amount of heat released during the combustion of a specified amount of food or fuel, the calorific value is a characteristic for each substance usually mass such as kcal/kg,kj/kg,j/mol,Btu/m3.

Heating value is usually determined using a **bomb calorimeter.**

I. **Higher heating value (HHV);** Determined by bringing all the products of combustion back to the original pre combustion temperature and in particular condensing any vapor produced.

II. **Lower heating value (LHV);** Determined by subtracting the heat of vaporization of the water vapor from the higher heating value. This treats the water vapourS. The energy required to vaporize the water therefore is not released as heat.

III. **Gross heating value (GHV);** Accounts for water in the exhaust leaving as vapor and includes liquid water in the fuel prior to combustion.

TRANSESTERIFICATION

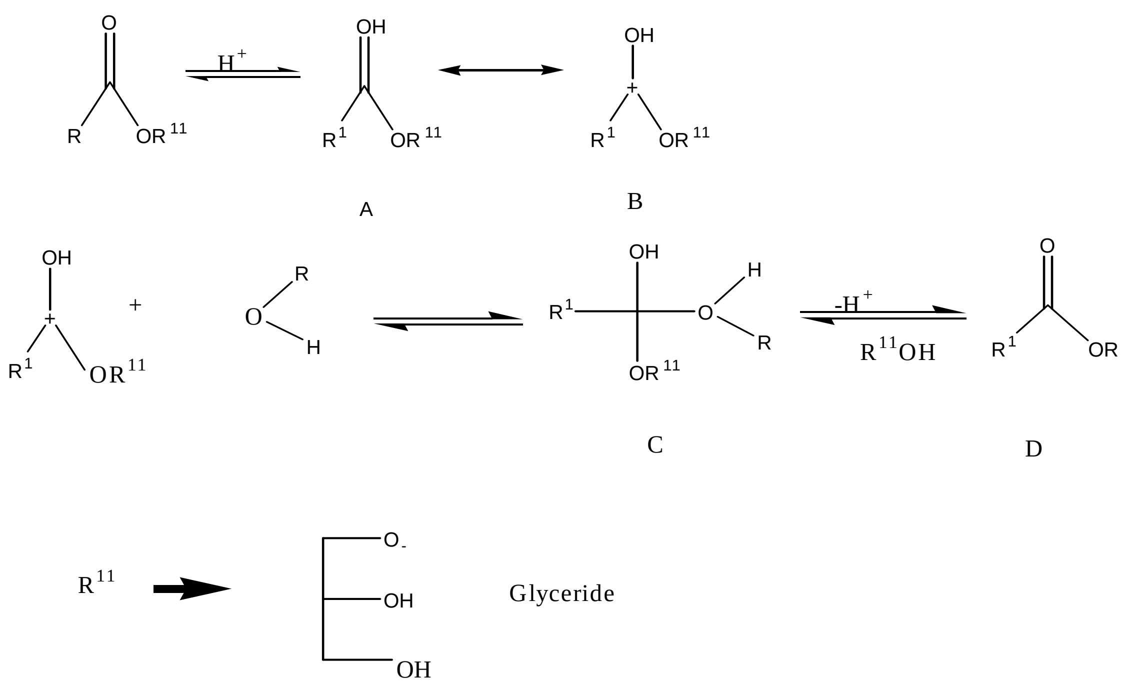
This is the process of exchanging the organic group R2 of an ester with the organic group R1 of an alcohol, this reaction are often catalyzed by the addition of an acid or base

Transesterification: alcohol + ester → different alcohol + different ester

Acids can catalyze the reaction by donating a proton to the carbonyl group thus making it more reactive, while bases can catalyze the reaction by removing a proton from the alcohol thus making it more reactive.

Transesterification is used in biofuel e.g. vegetable oil to power heavy engines.

A mechanism of an acid catalyzed transesterification of vegetable oil includes;



The protonation of the carbonyl group of the ester leads to the carbocation 2 which after a nucleophilic attack of the alcohol produces the tetrahedral intermediate 3 which eliminates glycerol to form the new ester 4 and to regenerate the catalyst H+.

VISCOSITY

Is a measure of the resistance of a fluid which is being deformed by either shear stress or extensional stress, this is also a measure of fluid friction. It is expressed in mm3/s. In fuels viscosity affects the combustion efficiency by lowering the heating value hence must be controlled. Biofuel e.g. Vegetable oil tends to have 15-

20 times the viscosity of diesel a fossil fuel. The relation to iodine value is that the higher the iodine values the higher the viscosity.

IODINE VALUE

This is the measure of the level is unsaturation of the oil and it the amount of iodine in grams absorbed per 100 grams of fuel. The higher the iodine value the higher the unsaturation of the oil.

SPECIFIC GRAVITY/SPECIFIC MASS

This is the ratio of density of a given reference material. Specific gravity means relative density with respect to water. The specific gravity of most oils and their methyl esters is higher than that of diesel fossil fuel. This is due to the larger molecular mass and chemical structures of vegetable oils. This helps in countering their low heating values in term of break specific fuel consumption. The density of substances varies with temperature and pressure.

TOTAL ACID NUMBER (TAN)

This is the amount of potassium hydroxide (KOH) in milligrams that is required to neutralize one gram of oil. In refinery the TAN value indicates to crude oil refinery the potential of Corrosion problem. Usually naphthenic acids in crude oils and carboxylic acids in biofuels cause corrosion.TAN values can be determined by potentiomeric titration or by color indicator titrations. Acid numbers for biodiesels in (mg/KOH/g oil) are preferred lower than 3.

STORAGE STABILTY

This is the ability of biofuels to resist chemical change while in storage; these changes include oxidation due to the oxygen present in air. The storage stability of biofuels is lower than that of fossil fuels e.g. bio diesel can turn from yellow to brown in time and develop a paint smell.

FLASH POINT

This is the lowest temperature to which a fuel has to be heated for it vaporize and form a combustible mixture with at atmospheric pressure. It is one of the descriptive characteristic of fossil fuel and biofuels. From literature and internet (www) liquids with a flash point less than 60 degrees are flammable and those above this temperature are combustible liquids. Examples of flash points include;

Ethanol=12.8^{o}c

Gasoline=<-40^{o}c

Diesel=>62^{o}c

Vegetable oil=327^{o}c

Flashpoint is not directly related to engine performance but it is an important property in fuels.

CLOUD POINT (CP)

This is the temperature at which wax crystals first appear in diesel or biowax. In bio diesel sample that is cooled under conditions described by ISO 3015. Solidified waxes and thickening of oils clogs air filters also injection ports in engines. The cloud point is determined virtually by inspecting for haze in the normally clear fuel. Other factors in fuels that are ***temperature*** dependent include:

CHAPTER 3

METHODOLOGY

Reagents and apparatus to be used in this research are available at the Isiolo Private Laboratory and their quality and analytical grade is of no question.

SAMPLING

- Cotton seeds /'Muui'seedsare to be bought locally at seed shops in Isiolo,meru
- Jatropha seeds are to be obtained at the Mwea environs.

PREPARATION OF SAMPLE

The different types of seeds collected are to be sorted and the unwanted parts discarded as waste. Seeds that need drying will be dried in an oven for 48 Hrs at about 45^{0}C prior to which the wet weight of seeds will have been taken and recorded and after drying the dry weight will be taken and recorded. The seeds will then be crushed in a mortar and pestle in increase the surface area for oil extraction.

OIL EXTRACTION

The ground seeds will have their weights taken and recorded as the mass of dry sample, the sample will then be soaked in n-Hexane for 48 Hrs so that the oil present in the sample dissolves in the n- Hexane and the remaining pulp is filtered out. The oil and n-Hexane are separated using a rotatory evaporator.

The percentage yield will then be calculated as follows;

$$\%\ yield = \frac{Mass\ of\ oil\ yielded}{Mass\ of\ dry\ sample} * 100\%$$

The oil is then stored for preceding experiments.

Transesterification

The formation of fatty acid methyl esters (FAME) through transesterification of seed oils requires raw oil, 15% of methanol & 5% of sodium hydroxide on mass basis. However, transesterification is an equilibrium reaction in which excess alcohol is required to drive the reaction very close to completion. The vegetable oil was chemically reacted with an alcohol in the presence of a catalyst to produce FAMEs. Glycerol was separated as a by-product of transesterification reaction (Rao et al., 2008). The transesterification process was carried out

Using two litres round bottom flask equipped with reflux condenser, magnetic stirrer, and thermometer and sampling outlet. One litre crude oil firstly filtered and heated up to 120°C to remove the moisture. The transesterification reaction performed at 6:1 molar ratio of methanol/oil, by using 0.34%, 0.67% and 1.35% (w/w) NaOH as catalyst. The temperature and the reaction time was maintained at 60°C and stirred for 2 hr with stirring velocity of 600rpm. The resultant mixture was cooled to room temperature for the separation of two phases(Plate 1-4). The upper phase contained biodiesel and lower phase contained glycerin (by-product).

Crude biodiesel contains the excess methanol, the remaining catalyst together with the soap formed during the reaction and some entrained methyl esters and partial glycerides

Purification

After separation of the two layers, the upper layer of biodiesel was purified by distilling the residual methanol at 60°C. The remaining catalyst was removed by successive rinsing with distilled water by adding 1-2 drops of acetic acid to neutralize the catalyst. The residual can be eliminated by treatment with anhydrous sodium sulphate (Na2SO4) followed by filtration. Transparent blackish liquid was obtained as the final product.

<u>BLENDING</u>

-The experiment is meant to compare the burning curve of fossil fuels to the curve of blending the extracted oils, the relationship between the burning curves will determine if f the non food oil seed are a combination substitute to fossil fuel that is paraffin and diesel. The blending ratio is one part oil extract to 0.75 part fossil fuel which is diesel or paraffin in my case.

<u>Blending</u>

-**20ml** of each oil is measured and added to either **15ml** paraffin and diesel and the mixture placed into a tin lamp, **50ml** of water is measured and placed in a conical flask and the temperature measured, the tin lamp is placed onto a tripod stand for heating using the blend in the tin lamp and temperature at intervals of **1min** to **5min** and recorded in the table below; The same procedure is repeated for the second oil sample

Jatropha/paraffin or diesel (time)	1min	2min	3min	4min	5min
Temperature ^{0}C	31	34	36	38	40

'Muui'seeds/paraffin or diesel (time)	1min	2min	3min	4min	5min
Temperature^{0}C	34	36	38	39	40

Diesel (time)	1min	2min	3min	4min	5min
Temperature ^{0}C	33	36	38	42	44

Paraffin (time)	1min	2min	3min	4min	5min
Temperature^{0}C	36	39	42	45	48

A graph **Temperature** against **Time** is drawn for all the above tables for comparison of burning curves of the oil blends with fossil fuels and deductions are made;

Observations

The **Jatropha** and **'muui'** oil blends with paraffin and diesel burning curves compete adequately with the burning capacities of paraffin and diesel at the same intervals of heating.

CHAPTER 4

Data Analysis

Determination of Free Fatty Acid (FFA) content

The FFA has significant effect on the transesterification of glycerides with alcohol usingcatalyst (Goodrum, 2002). The high FFA content (>1%w/w) will cause soap formation and the separation of products will be exceedingly difficult, and as a result, low yield of biodiesel product would be obtained. It is important to first determine the FFA content of oil. The free fatty acid (FFAs) number of hemp crude oil was 1.76%, neem 2.5 % and pongame 2%. According to Anggraini *et al*., (1999) if the free fatty acid content is more than 3% then the conversion efficiency decreases gradually.

Biodiesel yield

To achieve optimum yield of biodiesel from non edible oil seeds, alkali based transesterification was carried out. Alkali-catalyzed transeterification is much faster than acid-catalyzed and is used in commercial production of biodiesel. Even at ambient temperature, the alkali-catalyzed reaction proceeds rapidly usually reaching 95% conversion in 1-2 h (Rachmaniah et al., 2006). As a catalyst in the process of alkaline methanolysis, mostly sodium hydroxide or potassium hydroxide have been used, in concentration from 0.4 to 2% w/w of oil (Meher et al., 2006). Yield of methyl esters of HOB, NOB, POB and COB were investigated by changing catalyst concentrations while molar ratio (6:1) methanol / oil and temperature (60°C) was kept constant.The highest conversion rate was obtained with the catalyst concentration of 0.7 g, under these conditions the biodiesel yield was 74.36%, 70%, for jatropha and cotton seeds respectively. When the catalyst concentration was doubled to 1.6 g, it was observed that the ester formation decreased with the increase in sodium hydroxide concentration and soap formation was increased. This is because the higher amount of catalyst may cause soap formation (Attanatho et al., 2004). Soap formation reduces catalyst efficiency, causes an increase in viscosity, leads to gel formation and makes the separation of glycerol difficult (Guo and Leung, 2003). The Conversion efficiency decreased when the catalyst concentration was reduced to half (0.4 g), as low concentration of catalyst suppress biodiesel.

Biodiesel blends

Blending oils with diesel fuel was found to be a method to reduce chocking and extend engine life. Zhang and Gerpen (2006) investigated the use of blends of methyl esters of soybean oil and diesel in a turbo-charged,

four cylinder, direct injection diesel engine modified with bowl in piston and medium swirl type. They found that the blends gave a shorter ignition delay and similar combustion characteristics as diesel (Orchidea et al., 2007).Table 3 presents data pertinent to the mixture of petroleum diesel and biodiesel in the
following fashion:

Petroleum diesel (90%)- biodiesel (10%) : B10

Petroleum diesel (80%)- biodiesel (20%) : B20

Petroleum diesel (50%)- biodiesel (50%) : B50

The fuel properties of biodiesel blends of cotton and jatropha were compared with HSD. It was found that viscosity was slightly higher as the proportion of biodiesel in the mixtures increased. However, this event does not affect the atomization characteristics. Viscosity of B20 is very close to the viscosity of diesel. So that the biodiesel of B10, and B20 blends can be used without any heating arrangement or engine modification.

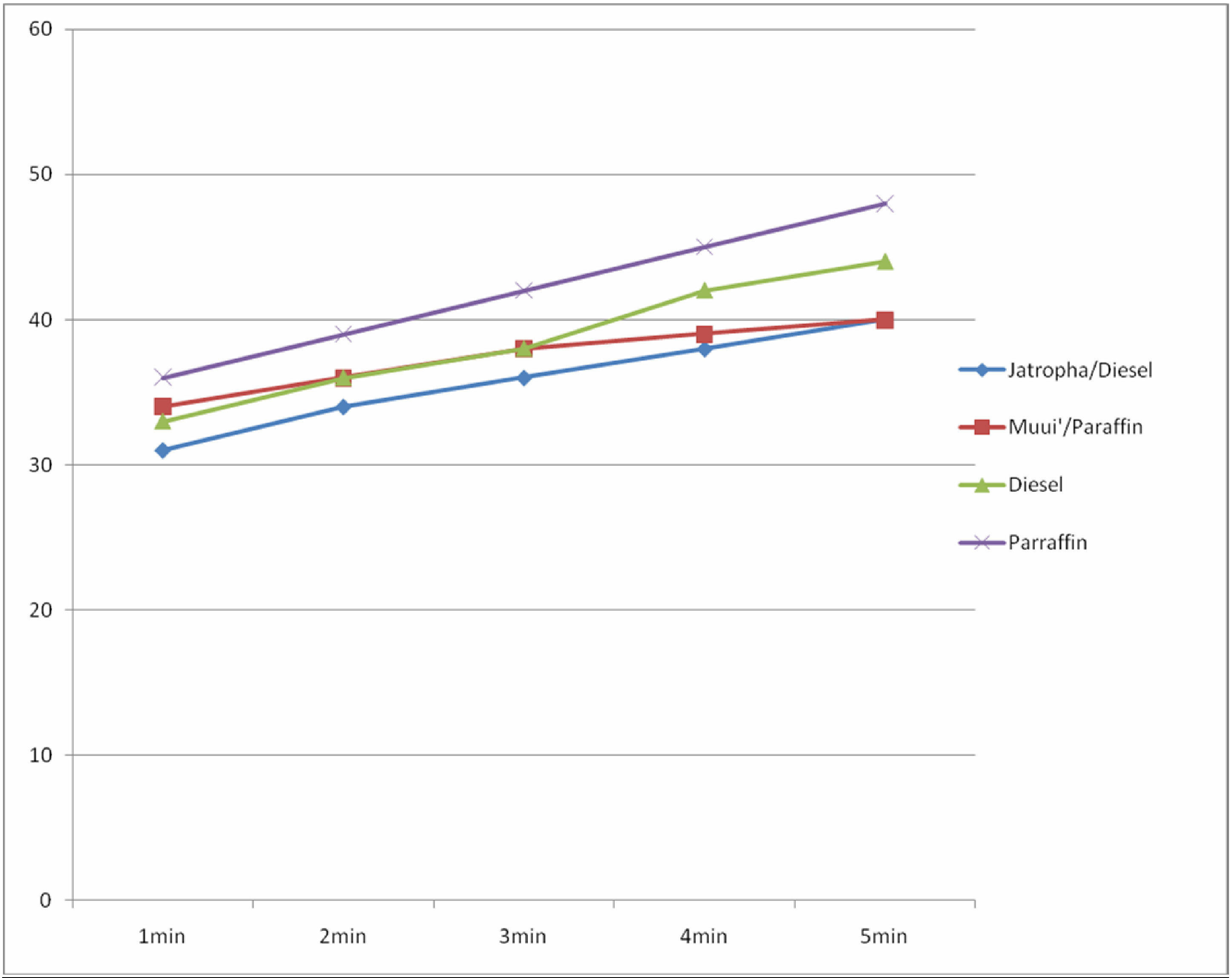
The density of different blends of methyl esters were increased with increase in blend percentage. The blends of B10, and B20 of NOB and HOB were closer to the density of diesel. The flash points of different blends of methyl esters are increased with increase in methyl ester percentage. It is also observed that the flash points of pure biodiesel were in comparison with HSD. Thus, it can be used as a fuel without any fire accidents.

Sulphur contents

The most valuable result is the reduction and absence of percentage of total sulphur contents in cotton and jatropha seeds that will result in reduction of SO_2 in exhaust gases which is one of the reasons of acid rain. Sulphurs content of petro diesel is 20–50 times higher than biodiesels (Shay, 1993).

From the data collected and graph drawn it is keenly observed that the burning capacity of oil blends adequately matched the burning curve of fossil fuels alone i.e. paraffin and diesel. This is because the organic complexes of fossil fuels and non food oil seeds burn adequately and at almost the same rate in time evolving adequate heat energy for utilization by ‘wananchi’ for cooking, lighting and engine ignitions in automobile. On food oil seeds do not burn effectively alone due to their high amounts of **cholesterol** and a process called **trans-esterification** has to be carried out to eliminate this cholesterol.

Graph of temperature against time to illustrate the above table data



Parameter Variation

The graph of temperature against time is collinear with the variations of time as the temperature rises in all the samples

CHAPTER 5

CONCLUSION

In this research we try to introduce nonfood oil seeds for bio-fuel production to ease the pressure on human food oil seeds. It is noted that some existing non food oil seeds have the capacity to act as bio-fuels when blended with other bio-fuels like ethanol, diesel and paraffin. In this research we extracted oil from this seeds and blended them with fossil fuels and determined their burning capability. Our objectives were to extract bio-fuels from 'muui' seeds and jatropha seeds and blend with paraffin and diesel and determine its burning capability and to create an alternative source of bio-fuel in non food oil seeds to ease the competition on human consumed foods.

During the course of these experiments it has been determined without doubt that non food oil seeds produce oils that are capable of being used as biodiesels after analysis of the physiochemical parameters was done and if utilized effectively the above mentioned objectives will fully meet an the theme of this year of Science and technology for the realization of vision 2030 .Our motivating pillar on realization of vision 2030 was economic stimulation as far as fuel production is concerned and further stimulation of food security.

In this study an optimized protocol for biodiesel production from non edible seeds of jatropha and cotton seeds converted into fatty acid methyl esters (FAME) through base catalyzed transesterifiction using an optimum ratio of 1:6 (Oil : Methanol) at 60oC. The fuel properties of biodiesel blends i.e. B100, B50, B20, B10 were compared with ASTM standards. Biodiesel from these sources was analyzed for qualitative and quantitative characterization by using H1NMR, C3NMR, GC-MS and FT-IR techniques. Based on qualitative and quantitative analysis of Biodiesel and their by products, it is concluded that the bio energy from these species can be feasible, cost effective, environment friendly, if mass plantation of such resources may initiated in suitable places at global perspective.

List of abbreviations

ASTM = American Society for Testing and Materials

B100 = 100 % biodiesel

B20 = 20 % biodiesel + 80 % high speed diesel

B10 = 10 % biodiesel + 90 % high speed diesel

B5 = 5 % biodiesel + 95 % high speed diesel

B50 = 50 % biodiesel + 50 % high speed diesel

C13NMR = Carbon - Nuclear Magnetic Resonance

COB = Castor Bean Oil Biodiesel

FA = Fatty Acid

FAME = Fatty Acid Methyl Esters

FFA = Free Fatty Acid

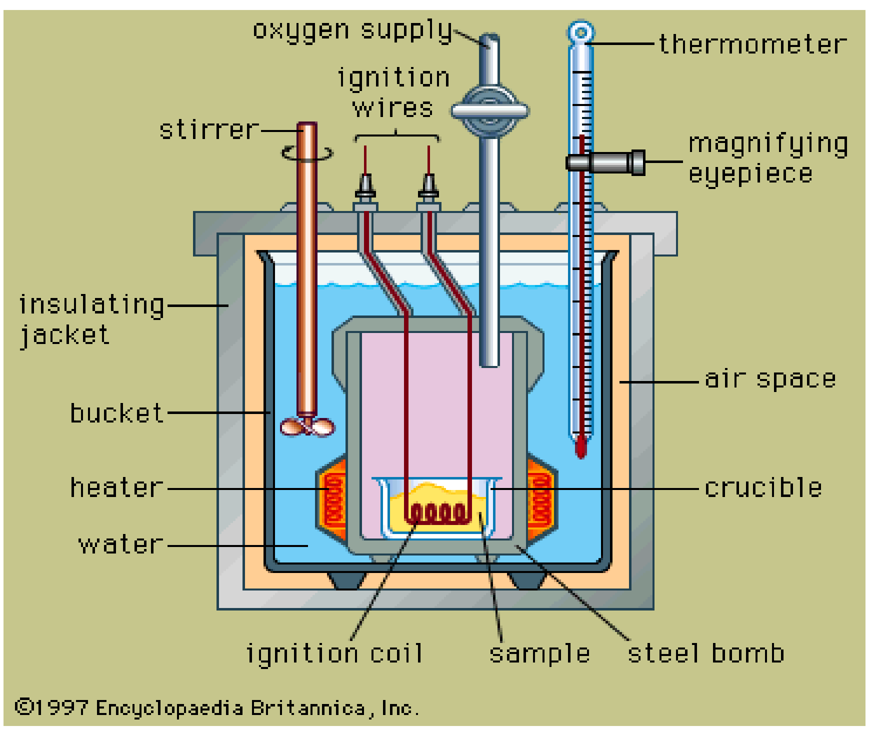
FT-IR = Fourier Transfer – Infra Red

GC-MS = Gas Chromatography – Mass Spectrometer

Recommendations

We are recommending an intensive campaign on use on non food oil seeds by stakeholders, sponsors and the government for the production of Non food bio-fuels to reduce competition with human consumed foods, cheaper fuel production and also increase our capacity on food security and be able to fully utilize our research objectives. **Appendix**

Bomb Calorimeter-instrument used to measure calorific value of fuels



-'Muui'-meru indigenous tree species

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	ITEM	DESCRIPTION	COST ESTIMATE(Ksh)
1	n-Hexane	2.5 litres	**4,000**
2	Transport	Sampling Sites(mwea,isiolo,Embu)Bob Calorimeter site	**5,000**
3	Stationery	Typing, Printing and Binding of Proposal and Report	**1,100**

4.0<u>BUDGET</u>

GRAND TOTAL	**Ksh 10,100**

MONTH(YEAR 2012-2013)	ACTIVITY
September-November 2012	Proposal Writing
January 2013	Extraction of Oils
February 2013	Physiochemical analysis of the extracts
March 2013	Compiling Research Project, typing and binding
April 2013	Presentation of Research project

TIME FRAMEWORK