IJAAR PUBLISHING®

African Journal of Environment and Sustainable Development | ISSN: 3027-2718
Vol. 3, Issue 1 (2025) | www.ijaar.org

Characterization of Fuel Oil from Pyrolysis of Allanblackia Floribunda Seed.

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ABSTRACT

Tallow seeds collected from locally and natural grown tallow tree (TT) in Nigeria and characterized for general physical and chemical properties. The seed was pyrolyzed at a product temperature of 125^0C – 325^0C in a time interval of 2hrs while the shell was pyrolyzed at a product temperature of 125^0C-270^0C. The volume of oil formed from 1kg of both seed and shell is 175ml and 50ml respectively. The product temperature is directly proportional to the time interval and is affected by the heat source. The volume of fuel oil formed was affected by the size of condenser used to trap vapor gas. The fuel oil for the seed oil and shell oil has a flash point of 85^0C and 79^0C and Pour point of -12^0C and -10^0C respectively. The oil formed can be used in the soap making industries and also can be used in making healing balm because of the fatty acid content.

Keywords: Fuel oil, Pyrolysis, Allanblackia floribunda, Seed oil, Thermochemical conversion, Biofuel production

Balogun T. A., Ere, W., & Aluko A. L. (2025). Characterization of Fuel Oil from Pyrolysis of Allanblackia Floribunda Seed. *African Journal of Environment and Sustainable Development. 3*(1), 75-91 DOI: https://doi.org/10.5281/zenodo.15763446

INTRODUCTION

1.1 Background of Study

History has accounted how men passed through various processes and stress that arise due to crude oil component and distillate, most of which facilitate into environmental pollution and flare gases that are being obtained from chemicals during the production of crude oil distillation. It has been a big problem to humanity even this for cost of obtaining crude oil from the market for individual uses in the form of fuel oil and kerosene and man has been looking towards it as a factor in which it has to be eradicated to improve normal development and life safety. Many industrialized states, states that base on their part on the production of crude oil such as Rivers State have been complaining of having contaminated or polluted air that is filled with chloroform hydrocarbons that are highly effective to human cells. Hence, facilitates into bacteria growth and as well making the environment unconducive for living which has now caused what they call a great impact on man's life and growth by affecting the lungs and internal organs of humanity. This has been a problem to most developing states, and right from time researchers have been thinking on how to develop a means or a process in which such problems can be eradicated to reduce the effect that might have been caused from crude oil product or production. Many persons have gone into such work, such as (Xias-Qia vaaz and change-yunHse) try to produce fuel oil from Chinese tallow seed (CTS) but their process were looked to be void because they were unable to satisfy the market needs and the needs of other industrial companies and facilities that will need such oil to produce their plant and other things and till date it has been a big problem to man in fringing out various means that can obtain or produce fuel without the use of crude oil means of production.

It has been known that creation comes with many things involved which some are medicinal and some are like fruits that can yield oil and most scientist have noticed that the amount of oil obtained from some fruits tends to be high and some of such oil have high volatility and some combustible and so many persons have been thinking of various means of extracting such oil using various means of extracting such oil using various means of heating, some using compressibility issues, some using distillation processes and new processes such as pyrolysis and other chemical processes.

1.2 Statement of Problem

As much attention has been given to the production of fuel oil using various raw materials and seeds specimen to produce good fuel oil for industrial usage and substantial use, the effect of pollution has not been controlled. And also, none have been able to produce good fuel oil through the characterization and Pyrolysis of tallow seed. Thus, with this research it is believed that such problem will be minimal and it will be in more benefit to our environment, industries and other allied industries.

1.3 Justification and Significance

This research is necessary because of the importance of fuel oil production. Also, to extract fuel oil from tallow seed, characterize the fuel oil, use the oil as fuel that can be useful to plant of both low and high engine.

1.4 Aim of Study

The aim of this research is to characterize fuel oil produced from tallow seed through pyrolysis or pyrolytic process.

1.5 Objectives of Study

My prime objectives of this research are as follows:

a. To understand the chemical properties and composition of tallow seeds and how they can be effective for oil production.
b. Development various means of extracting perfect oil using pyrolytic processes to obtain the oil from tallow seeds.
c. Characterize the oil to figure out the fundamental properties of the oil with respect to gasoline and all other fuel oil.

1.6 Scope of Study

The major focus on this research is to investigate towards, how to extract fuel oil from tallow seeds, understand the chemo-properties of tallow seed and how to characterize such fuel to see if it will match with the qualities of gasoline obtained from crude oil distillation and as well how to extract oil from tallow seeds which is believed as well that the volatility may be able to attain the level of all other ones that can be used for final production.

So many major scopes of study are investigating towards extraction of fuel oil from tallow seeds which are known to be organic seeds produced from Nigeria Tallow Tree (NTT). Having a chemical composition of fatty acids, Oleci, unoleic acid, and even hexanoic acid and of which checking out the chemical analysis of tallow seeds. The particular amount of fuel oil can be obtained from there and with all level of research such oil may have sole volatile nature which could be used as fuel for and by some engines and machines. From this research, the fuel oil produced can be used as raw materials in various industries.

LITERATURE REVIEW

Bio-based materials have received increasing global alteration because of the increasing environmental and economic concerns regarding fossil fuels. Vegetable is an alternative raw material used to prepare bio-based materials.

The tallow tree also known as sapiumsebiterum, (TT) is a native to China and is one of the most promising oil seeds crops. The fast-growing tree has more than 100,000 metric tons annual production of seed oil in China. Seeds of CTT are the size of a pea, and an outer coating of vegetable tallow and fiber cover a hard bruttle shell which contains a small embryo and abundant endosperm. The endosperm is composed of a high protein meal and a drying oil. The CTT seed contains approximately 40 – 70% fatty acids and yields two different types of fats; a nontoxic Chinese vegetable tallow (CVT) which is in the external tallow coating, and mildly toxic kernel oil in the endosperm which is commonly called stillingia oil (so) interest in CTT seed oil has been historically focused on CVT for the manufacturing of soap, candles, cocoa butter equivalent, and dairy creamer. The seed is used to produce textiles, varnish, native paint, lighting and heating. Chinese tallow tree was introduced into North America as an economic dant in the late 1700s and has been considered an invasive species throughout the South Eastern United States since the mid-1900s. A major pathway for the invasiveness of CTT is via seed dispersed by birds. Removing and using the CTT seed as a feedstock for bio-material production could be an effective way to control its dispersion and the species invasiveness. In addition, CTT seed oil is not edible by humans.

2.4 Pyrolysis of Tallow seed

Pyrolysis is a process of chemically decomposing organic materials at elevated temperatures in the absence of oxygen. The process typically occurs at temperature above 4300 C (800 0

F) and water pressure. It simultaneously involves the change of physical phase. and chemical composition and is an irreversible process. The word pyrolysis is coined from the Greek word "Pyro" which means fore and "lysis" which means separating.

pyrolysis is commonly used to convert organic materials into a solid residue containing ash and carbon, small quantities of liquid and gases. Extreme pyrolysis on the other hand produces carbon as the residue and the process is called carbonization. Unlike other high temperature process like hydrolysis and combustion; pyrolysis does not involve reaction with water, oxygen or other reagents. However, as it is practically not possible to achieve an oxygen-free environment, a small amount of oxidation always occurs in any environment. Pyrolysis is frequently associated with terminal treatment. but in contrary to combustion and gasification process, which involves entire or piratical oxidation of materials. pyrolysis bases on heating on the absence of air. This makes it mostly endothermic processes that ensure high energy content on the products received. Pyrolysis products always produce solid (charcoal, biochar), liquid and non-condensable gases (H2, CH4, CO, CO 2 and N).

During the pyrolysis; a particle of materials is heated up from the ambient to defined temperature (setup temperature of Bio-green equipment). The material remain inside the pyrolysis unit and is transported by screw conveyor at defend speed, until and complexion of the process. Chosen temperature of pyrolysis defines the composition and yields of products (pyrolysis oil, syngas and char).

Occurrence and uses

Pyrolysis is usually the first chemical reaction that occurs in the burning of many solid organic fuels like wood, cloth paper and also some kind of plastic. In a wood fire, the visible flames are not due to combustion of the wood itself, but rather of the gases released by its pyrolysis, whereas the flame-less burning of a solid called shouldering smoldering is the combustion of solid residue (char or charcoal) left behind by pyrolysis. Thus, the pyrolysis of common materials like wood, plastic and clothing is extremely important for fire safely and firefighting. In pyrolysis these is a gas phase present. It should not be confused with hydrothermal reactions such as hydrothermal gasification, Hydrothermal liquidation and hydrothermal carbonization which occur in aqueous environment because the temperature and reaction pertaining differ, with ionic reactions favoured in the absence of water.

Types of pyrolysis

There are three types of pyrolysis reaction differenced by the processing time and temperature of the biomass.

a. Slow pyrolysis
b. Flash pyrolysis
c. Fast pyrolysis

2.1 Extent of Past Works

A number of studies on the production of oil from seed have been carried out on recent years, which some will be reviewed so as to relate with this research work for a good report yield.

Bharzavity*et al*, (2018) carried out a study on the production of Biodiesel from thespesiapopulnea seed oil through rapid in situ transesterification.

Influence of reaction parameters such as catalyst type and concentration, methanol to biomass ratio, co-solvent volume, temperature and agitation speed on conversion of oil into methyl esters was investigated. The effect of different co-solvent on conversion of 97.80% was achieved at 1.5wt% of KOH catalyst, 5.5:1 (vlw_ methand to biomass ratio 25 vol % tetracydroturanco-solvent, 60°c and 508 rpm within 120 min of reaction time.Fuel properties

of produced methyl esters were well fitted within the limits of ASTMD 675 standard. Considering the properties of produced biomass, thespesia populnea seed derived biodiesel can be used as potential alternative to fossil diesel fuel.

Samuel *et al,* (2019) carried out a research on the Production of fatty acid ethyl esters from rubber seed oil in hydrodynamic cavitation reactor. In their research states that the attribute of environmental balance, lower exhaust emission and renewability have made ethylic biodiesel production a preferable technique to methylic biodiesel production from inedible lipid oil. Hydrodynamic cavitation reactor (HCR), in particular has engaged a global interest due to its flexibility and desirable biodiesel properties for the first time, the study adopted HCR to produce ethyl. This research was good but it didn't meet up the demand for fuel oil.

Ademiluyi *et al,* (2004) carried out a research on potentials of waste water sachets for the production of fuel oil was evaluated. In this work, waste polyethylene (pure water sachets) was pyrolysed at different temperatures: 130 - 190°C, 200 -300^{0}C, and 300 – 450°C using a batch reactor. Below 200°C, 78% of the waste was converted to wax, 18% to fuel oil and 3% to non-condensable gases. The wax content decreases as temperature increases. The highest quantity of fuel oil was produced between 300°C - 450°C. The pyrolysis was found to increase with temperature. 86.5% of fuel oil was recovered from waste polyethylene at a reaction time of 135 minutes by pyrolysing up to 450°C. The chromatographic analysis shows that the fuel oil produced (up to 450°C) contains paraffins, isoparaffins, olefins, naphthalenes, aromatics and polyaromatics ranging from C3– C38... It could be refined further to produce domestic kerosene and gasoline.

Thanzarasu *et al.* (2019) carried out a research on the production of biodiesel from Aegle marmelos correa seed oil for fuel cell. According to their research I quote "energy acting an important role in the development of any country. In an energy country like India, energy plays an important role to fulfill the energy demand by the industry as well as society. Each year there is an increase in demand for energy. Currently, most of the demand of energy is filled with a petrol-based product that creates the problem of sustainable support of energy and increasing problems like, production global warming, etc. The huge quantities of energy require a huge amount f fuel spending this huge amount of fuel across the world have adverse effect on the environment which cannot be altered after damage being done. Energy production from fossil fuel is the main reason for environmental degradation which effects on human health, disturbs the ecological equilibrium and biotic diversity. There is a requirement of the alternate and renewable source to tackle the energy demand as well as keeping a safe environment. This work was aimed at emphasizing the production of biodiesel from Aezle. Marmelos correa seed. Maximum biodiesel yield of 95% was obtained using a potassium hydroxide catalyst physical and chemical properties of biodiesel were determined as per American society for testing method D6751 standard. It was concluded that biodiesel produced from Aezlemarmelos correa seed oil can be another energy source to substitute the petroleum diesel fuel".

Ghinting*et al,* (2020) carried their research on potential of durian, avocado and jackfruit seed as raw material of bioethanol. According to this research, it was stated that the using of fuel oil is very consumptive so that it increases every year, as decreasing the availability of non-renewable natural resources, therefore the use of alternative energy (renewable energy). Renewable energy is a natural source of energy produced that will not be exhausted and can be sustainable if managed properly among another biofuel.

The purpose of this article was to review the potential of tropical fruit seeds: durian, avocado and Jack fruit which was used as raw materials for bioethanol production which includes stages: starch extraction, hydrolysis process using acid as catalyst, and fermentation. From available research data, the potential of tropical fruit seeds needs to be developed as raw materials for making bioethanol.

Avendano *et al.* (2020) carried out a research on the production and characterization of biodiesel from Annona muricata seed oil. The purpose of this research was to extract the oil from Annona Muricata (gzoyabano) seeds and convert it to biodiesel by esterification using hydrochloride acid and transesterification using potassium hydroxide. The average oil yield was 18.92% which the average crude biodiesel yield was 94.76%. The characterization results of the biodiesel composed of 5% groyabano methyl ester in commercial diesel (B5) were all within the limits set by the Philippine national standards (PNS).

Nevertheless, it was suggested that pure znyabanno biodiesel has the potential to be utilized on diesel engines but this suggestion was not put into use by major industries.

Bachrun *et al.* (2020) carried out a research on synthesis of biodiesel from kapok seed oil using CaC/Dolomite catalyst and its comparison with homogeneous catalyst. According to this research; Biodiesel as renewable energy resources has been attracted more intense study because of the alternative effort to reduce dependency of fossil fuel. Commonly, biodiesel production is produced using edible oils as feedstock. However, the problems related to the competition between foods versus energy supply have been concerned in the past few decades.

The dependency on edible oil as biodiesel feedstock could be reducing by using non edible oil. Furthermore, non-edible oil as feedstock will make the biodiesel price appropriate to complete with fossil fuel process. In this research, syntheses of biodiesel from Kapok seed oil using CaO/Dolomite catalyst as heterogonous catalyst and its comparison with homogenous catalyst was studied.

The properties of CaO/Dolomite catalyst were determined in term of porosity analysis (adsorption and desorption of Ne) crystalline structure (X-Ray O, filtration), and analysis element, composition (X-Ray fluorescence).

The biodiesel yield as high as was 92.7% achieved at following reaction condition: 60oC of reaction demonstration 3:1 methanol to KSC mass ratio, and catalyst amount 10wt.% of KSO.

Viznesh *et al, (*2020) also carried out a research on the Feasibility study of extraction of bio-oil from leucaena leucocephala seeds for sustainable habitat development. According to the research made in their article was certain measures were connected but to an extent. I quote; the world is facing serious threat due to global warming. Several measures have been proposed and the cost-effective solution will be the tree plantation". However, each tree has its own Co2 absorption rate and growth. Based on the literature review, leucaena leucocephala plant has the highest CO2 absorption rate and higher rate growth. Also, it is a tropical tree which can be grown in waste land in rural areas. The tree has multiple benefits like its leaves being used as fodder and the stem as fire wood. In India 100,000 hectares of land has this plantation and it yields 12,000 MT of biomass per year. It has been found that 30% oil yield can be obtained from the seeds. This oil has a calorific value of 39 MT/Kg

which can replace the fossil fuel consumption. However, the present research work identified another route for bio-oil production from the seeds. The present work attempts to utilize the seed of leucaena leucocephala for bio-oil production. This research was not put to use because of certain measure that was not demonstrated for global positive effect and usage.

Gohacin *et al, (*2018) carried out a research on biodiesel production from tea seed oil. Biodiesel seems to be one of the feasible alternative fuel with all the requisite characteristics for partial or total substitution of diesel fuel. In this regard, the present study aims to study the feasibility of producing biodiesel from Tea seeds oil (TSO). Tea, being a major plantation crop of Assam, its seeds are abundantly available in the region. The transesterification of tea seed oil with methanol was done in the presence of potassium hydroxide (KOH) as a catalyst and the resulting tea biodiesel (TSB) was characterized by 1HNMR and FTIR analysis. The biodiesel produced was also tested for its fuel properties, diesel engines performance and emission characteristics as well as its rheological behaviour. The fuel properties of TSB met both ASTM D6751 and EN 14214 biodiesel standard and were found comparable to diesel from other non-edible oil. The rheological behaviour of TSB and its blend with petrol diesel exhibit near and Newtonian behaviour. The engine performance and emission characteristics showed that TSB can be used on diesel engine without any engine modification.

Aza wondwonsenet al, (2020) carried out a research on Biodiesel production from Ethiopian Besana-Qotamacrostachyus seed: characterization and optimization. This study explores the potential of the Gota macrostachyics seed, a non-edible feedstock found, abundance on the South-Eastern part of Ethiopia, for the production of biodiesel.

Pyrolysis was used to extract, 53.34% of the oil from the Groton macrostachyus seed. This oil was further purified and the resulting product was known as the purified Croton macrostachyus seed CP-CMS) oil.

After obtaining the P-CMS oil, biodiesel was produced by the transesterification process. Focus was made on the optimization of biodiesel production by varying the identified process parameters, through the Box-Belaken Design using response surface methodology (RSM). The grade biodiesel was purified, characterization and compiled with ASTM D6751, United State and the EN14214, European Union standards. The optimum conversion efficiency of the P-CMS oil to fatty acid methyl either (FAME) was 96% at the optimal condition (6:1, methanol to oil ratio: 1%, catalyst (oadering:50°C, reaction temperature). A plan for the environmental impact assessment and life cycle assessment were provided to evaluate the sustainability of this new feedstock and the biodiesel produced from it. Results of these studies indicated the prospective of Croton maorostachyus seed as a new biodiesel feedstock.

Tan viet*et al,*(2017) carried out a research on Hydroprocessing of rubber seed oil (RSO) with various types of alumina-silica support catalyst was conducted at 400°C and a hydrogen partial pressure of 3.0 MPa in 3 hours.

The effects of the alumina-silica and metal doping on alumina-silica on the conversion, and distribution of oil fraction products. Initial boiling point (IBP) to 80°C, from 80-20°C from 200 – 360°C and higher than 360°C boiling point were investigated. Compared to the result obtained when using MO @ $Al_2 O_3 – S_iC_2$, hydro processing of RSO resulted in a higher conversion and much higher yield of the high fraction (BP 2 230°C). Both alumina-silica catalysts led to an improved conversion as well as a higher light fraction yield. Results show that hydro processing of RSO with metal doping on alumina-silica support was more efficient than only $Al_2 O_3 – S_iC_2$.

All these and more are researches done and carried out efficiently by other researchers but their result was not able to match the results that will be produced by this very project (the characterization of fuel oil from naturally grown tallow seeds using pyrolysis).

2.2 Limitation of Previous Works

Bagari *et al*, (2018) in this work, various measures was outlived and experimented, but the final result was not in resonance with the expected result.

In the population of fatty acid ethyl esters from rubber seed oil in hydrodynamus aviation reactor by Samuel *et al*, (2019), the value of some of his parameters such as pour point value and some were limitations in the research made.

Thanogarasu *et al*, (2019) did their research to majority solve the need problem of energy supply. In their research, the work was limited because of the chemical content of the product yield.

The feasibility study of extraction of bio-oil from Ceucaena Leucocephala seeds done by Vignesh *et al*, (2020) was not 100% successful current work to be performed.

In the research of (Ademiluyi *et al*, 2004) the type of lagging used was found to affect the yield.

2.3 Current Work

The current work on the study is to characterize fuel oil gotten from Nigeria tallow seed through pyrolysis the process to be taken include;

i. Extraction and characterization of fuel oil
ii. Pyrolyzation of the tallow seed
iii. determine the chemical composition and property of tallow seed and fuel oil
iv. check the efficiency of the oil obtained.

MATERIALS AND METHODS

3.1 Materials

The materials used and divided into two major parts, namely:

a. Primary materials
b. Secondary materials.

Primary materials are the raw materials for experiment i.e. Nigeria Tallow seeds. The CTT seeds were manually harvested from naturally grown trees. The seeds were air dried for 2-3 days and separated from the husk, branches and were put in sealed plastic bags and stored in a freezer at 20°C.

Secondary materials are chemicals to be used for the experimentation, used for separating the tallow coating from the kernel. this treatment rendered the tallow coating soft and tender during separation which was accomplished by washing.

3.2 Instrument

Instrument used during the chemical processes are as follows:

a. Batch reactor
b. Host
c. Water source (Tap)

d. Measuring cylinder
e. Condenser
f. Heating source.
g. A gas
h. Thermo couple
i. Rector-stand.

A reactor unit made of mild steel was constructed with an hopper and connected to a glass condenser. The reactor was adequately lagged for proper condensation of the gaseous product. The heat of reaction is supplied from an 8kg cooking gas cylinder. The cooling water was at 25^0 C. The condensed oil was received in a measuring cylinder to monitor the rate of product formation. A thermocouple was connected to the reactor to monitor the reaction temperature.

3.3 Methods

The balance was checked for zero error then empty clean and dry batch reactor was weighed and recorded. The feed "Tallow seed" from tallow tree were put will be weighed and recorded then into the reactor and heat for hours to yield the fuel oil under measurable temperatures with all values and data recorded. The process is repeated with alteration in the feed mass or quantity and all readings taking for every change in feed quantity, to be used for physiochemical analyses to ensure that the oil produced is of standard.

The tallow seed were obtained from a fruit processing industry and farm in Rivers State (Oyigbo region of Port Harcourt). About 10kg of the tallow seed was bought which were already processed with its kernel remaining on the seed. The shell coating the seed was removed and separated and the amount of tallow seed measured was 1kg was gave a separate seed weight and shell weight of 763g and 332g respectively. This was done to know the different amount of seed and shell weight that will be gotten from 1kg of tallow seed. From this it was known that 3kg of tallow will give 1kg of the seed shell.

Thus 1kg of the seed shell was extracted from 1kg of tallow seed to carry out the pyrolytic process and also 1kg of seed was extracted from the tallow seed for the research the 1kg of seed was gotten from a total weight of 1.4kg of the tallow seed.

The seed and shell were washed and dried simultaneously. And after drying for 48hours, it was taken out for grinding mechanically. After grinding, the weight of the seed and the shell between 769g and 1044g respectively. The weight of both shell and seed after washing and drying was 1058g and 827g respectively.

The total amount of mass of seed before pyrolysis which was put into the reactor was 769g. To obtain the seed oil, the research was done at different time interval with respect to the start time and heat was applied. The pyrolysis was also carried out at 125^0C-325^0C and 125^0C-270^0C to obtain the yield and also the effect of temperature on the products formed.

3.4 Characterization of the Oil

The composition of fuel oil are based on its biomass, therefore a quantitative chemical analysis is necessary to evaluate the physical and chemical properties of the biomass as the chemical functionalities of the fuel oil correlate strongly with the original feed stock due to the different chemical composition.

3.4.1 Determination of Viscosity

The kinematic viscosity was determined using the viscometer. The fuel oil is poured through one arm of the viscometer to fill the bulb to the mark guest above it. Air is poured through the other arm which causes the oil to rise in the capillary tube to the top mark. The oil is allowed to fall freely to the bottom mark and the time of fall is recorded with a stop watch.

Kinematic Viscosity = time in second x viscometer constant (3.1)
where viscometer constant = 0.0076. (3.2)

3.4.2 Determination of Specific Gravity

25ml or 50ml density bottle was used to determine the specific gravity of the oil. The bottle was washed properly with water then weighed; the weight of the empty bottle was recorded as W1. It was filled with water and the weight was recorded with W2. The bottle was dried and filled with fuel oil sample and weighted as W3 also recorded the value.

Specific gravity is calculated as express:

$$\text{Specific gravity is} = \frac{\text{mass of substance}}{\text{Mass of equal volume of water}} \quad (3.3)$$

Its SI Unit is kg/m^3

3.4.3 Determination of Flash Point

The flash point of the fuel oil was measured by open cup or closed cup flash point tester. The sample was properly cleared with a solvent and allowed to dry for some few minutes then the sample was charged into it and place in the flash point eating chamber. a thermometer was inserted to monitor the temperature rise of the fuel oil; the apparatus was set to operate at 5^oC per minutes flame was introduce are at intervals through the ignition nozzle of the vent and the temperature of ignition of the fuel oil is recorded at the flash point.

3.4.4 Determination of Pour point

The poor and cloud apparatus were used to determine the cloud point and the poor point of the fuel oil sample. The apparatus contains RCM high glass tube of 3cm diameter which were filled with freezing mixture of sodium chloride crystals and crouched ice and these were placed in the air jacket. The fuel oil was filled into a glass tube and placed on the air jacket, and was taken out at intervals of 10^c decrease in temperatures and inspected. The temperature at which the haze was seen at the bottom of the fuel oil was recorded as the cloud point. 10^c above the temperature at which no motion of the fuel oil was observed when titled in a horizontal position of sec was recorded at the poor point.

3.4.5 Determination of pH

The PH of a solution is the negative logarithm of the hydrogen ion activity, which may be measured potentiometrically. The determination of the pH value is carried out by measurement of the potential difference between electrode immersed in standard and text solution.

3.4.6 Gas chromatography mass spectrometry (GC-MS)

This is an analytical method that combined the features of gas chromatography and mass spectrometry to identify different substances within a test sample. Application of GC-MS include drug detection, fire investigation, environmental analysis, explosive investigation and identification of unknown sample obtained from planet mass during probe mission as early as

10,70s it can also be used in airport security detect substances on luggage or human beings. It allows analysis and detection even of tiny amount of substance.



FIG 1: Diagram showing Gas chromatography mass spectrometry (GC-MS)

3.4.6 Determination of Volatile Matter

Volatile matter us one of the most common parameters measured in coal. It is part of a standard proximate analysis volatile matter is essentially a measure of the non-water gases formed from an oral sample during heating. It is measured as the weight percent of gas (emissions) from a coal sample that is released during heating to 950°C in an oxygen-free environmental, except for moisture at standardized temperature. Volatile matter is measured directly in the automated proximate analyzer. Result is present in weight percent.

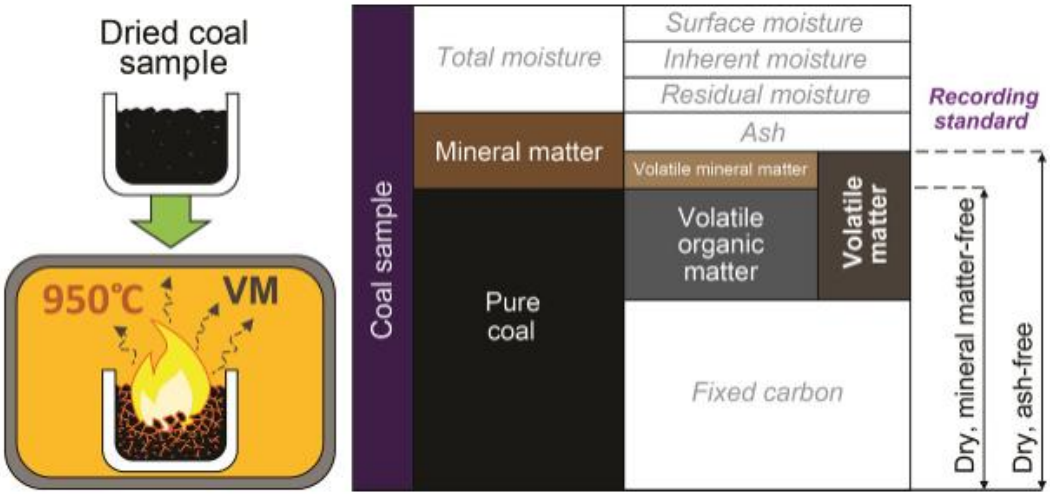

Fig 2. Diagram of equipment used in the determination of the volatile matter

RESULT AND DISCUSSION

4.1 Determination of Fuel Oil Yield with respect to Temperature

From figure 4.1 shows that the total amount of oil extracted (in vol) was 175ml at a product temperature of 125^0 C. The volume of oil produced from 1kg of seed remained constant at 300^0C.-325^0 C. The outlet water temperature remained constant beginning from the first volume of oil produced (20ml) at 125^0 C. to 325^0 C. The time of research is 2hours, and the mass of seed after pyrolysis is 140g. Mass of Gas before and after pyrolysis are 7kg and 4.155kg respectively.

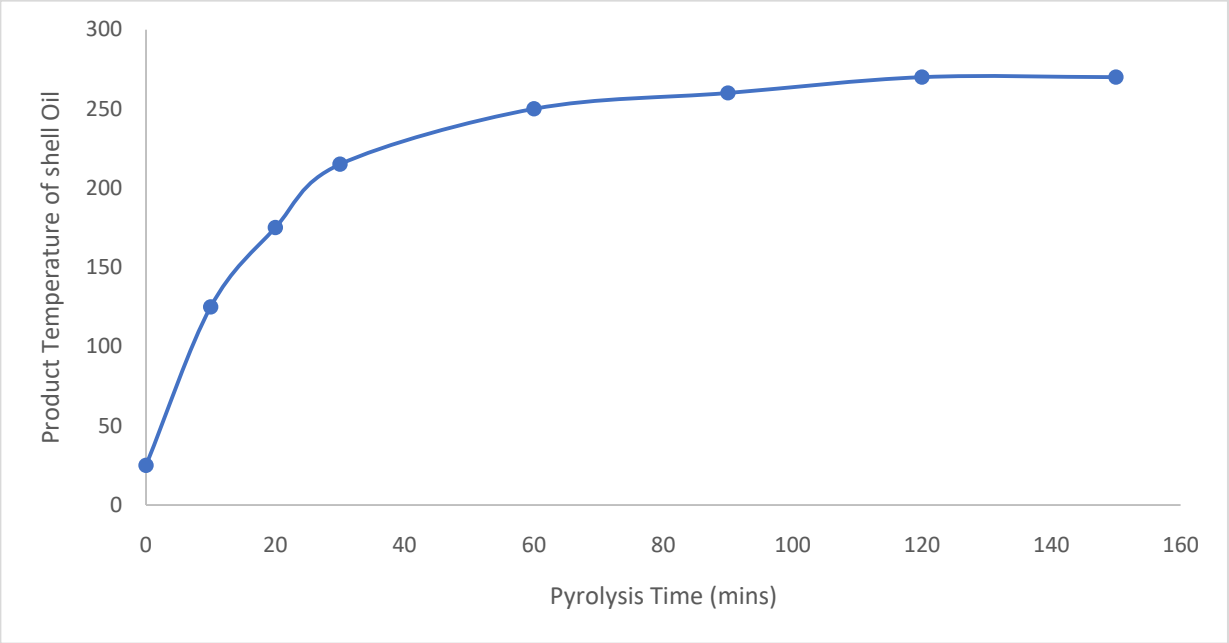

Fig 4.1: Showing Product Temperature of Shell oil from Tallow Seed.

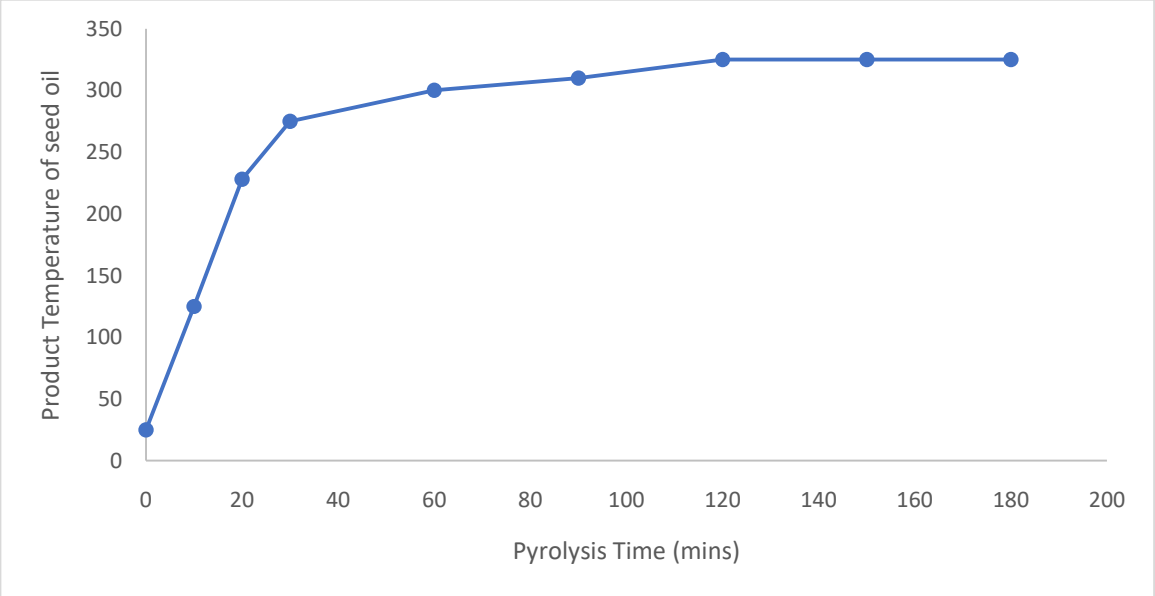

Fig 4.2: Showing Product Temperature of Shell oil from Tallow Seed.

The same research was carried out on the shell as shown in fig.4.1a, the total mass of shell before pyrolysis is 1.044g, this mass of shell was fed into the reactor and was heated to obtain oil from the shell. In order to obtain the shell oil, the research was done at different time interval with respect to the start time of the research. The product temperature is directly proportional to the time of reaction. The increase in time affects the product temperature of the fuel oil. At 0-10min the first product was formed at a product temperature of 125^0C. After additional 10mins the product temperature increased to 228^0C. The product temperature remained constant at 325^0C after a time interval of 1:50hr. The volume of oil formed during pyrolysis remained constant at a constant product temperature of 325^0C for the seed and 270^0C for the shell.

Fig 4.3 & Fig 4.4 show graph of the volume of both seed oil and shell oil against pyrolysis time. The graph shows that the total volume oil produced from 1kg of mass of shell is 50ml at a product temperature of 125^0C. to 270^0C. It was observed that the volume of oil production stopped at 260^0C – 270^0C, at a constant outlet water temperature of 28^0C.

The mass of shell after pyrolysis is 386.36g while the mass of gas before and after pyrolysis are 4.155kg and 2.875kg respectively. The inlet temperature of water is 25^0C. The temperature was measured by a thermocouple and thermometer throughout the research/reaction processes. The product yield increase as the reaction temperature increases. The product yield also increases with time. 86% of the seed oil from 1kg of the tallow seed was converted to fuel oil samples heated up to 325^0C for 2hours.

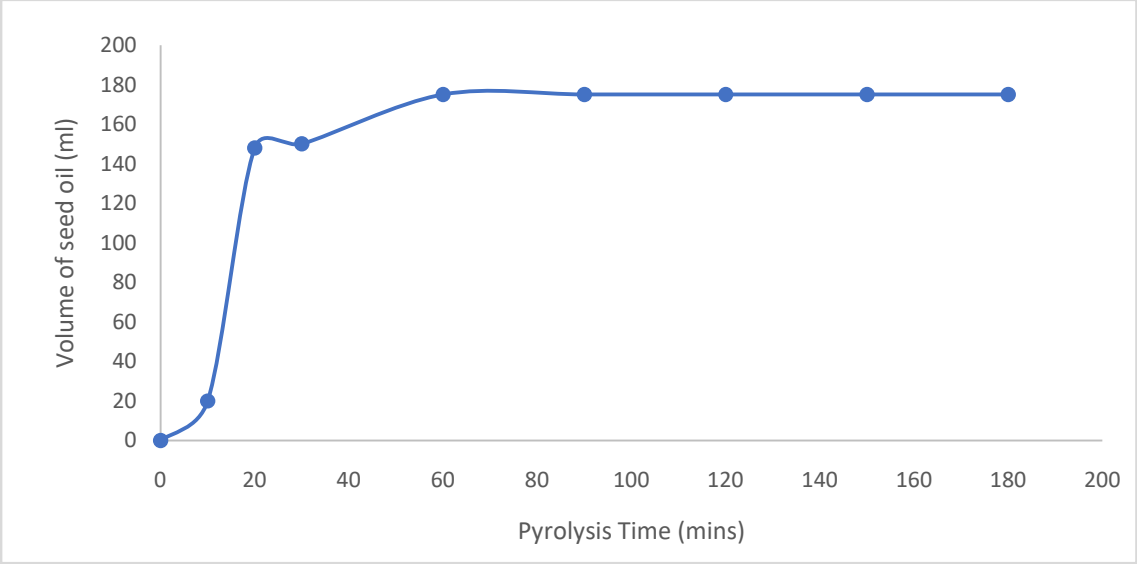

Fig 4.3: Showing Volume of Seed Oil against Pyrolysis Time

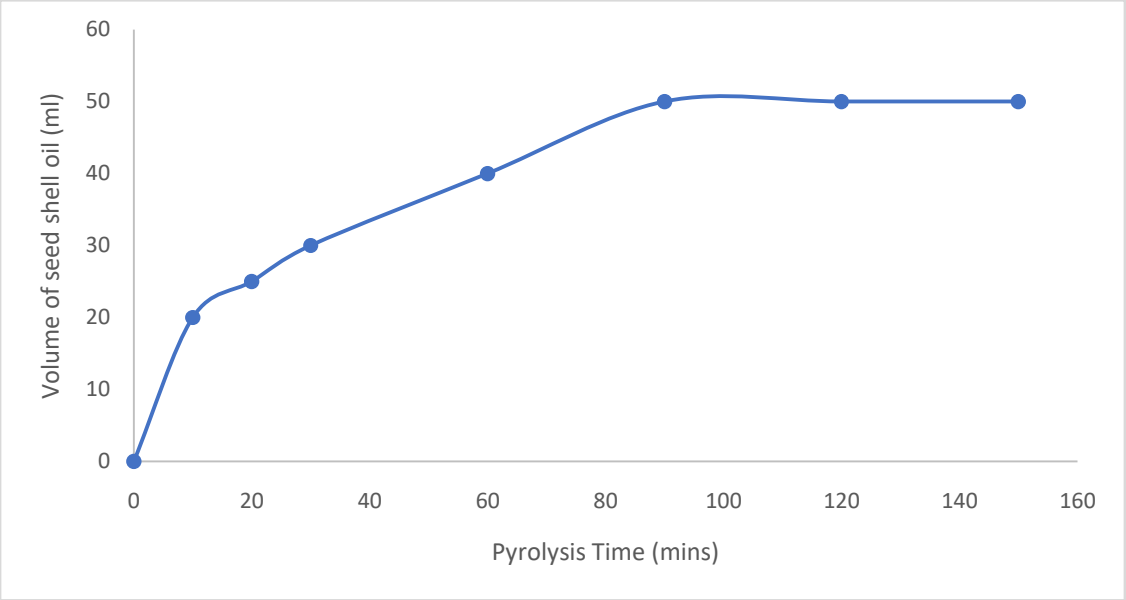

Fig 4.4 Showing Volume of Shell Oil against Pyrolysis Time

4.2 Determination of Physical Properties of the Fuel Oil from both Seed and Shell Oil

Table 4.1 shows the physical and chemical properties of the fuel oil produced which were determined using American Standard of testing method and Standard chart for fuel oil produced were compared with that of other fuel oil and were found to compare favorably with seed oil extracted by other researchers and their literature.

Table 4.1: Typical properties of fuel oil produced

S/n	Properties	Unit	Nigerian Tallow Seed	Nigerian Tallow Seed Shell
1	Bulk density	g/cm^3	0.815	0.985
2	Specific gravity	g/m^3	0.815	0.985
3	Color	-	Thick brown	Light yellow
4	Physical state	-	Thick liquid @28^0 C.	Liquid
5	pH	-	7.0-Normal	6.4-Acidic
6	Kinematic viscosity	m^2/s	0.109 at 60^0 C.	0.1166 @28^0 C
7	Flash Point	^0C	85^0C	79^0C
8	Pour Point	^0C	-12^0C	-10^0C

4.3 Determination of Kinematic Viscosity at different Temperature and Time

Fig 4.5 & Fig 4.6 below shows the behavioral pattern of the fuel oil obtained from the seed. It was discovered that the volatility (movement) of the fuel oil is dependent on the temperature. The increase in temperature causes increase in volatility and reduces the viscosity of the fuel oil. Different test for viscosity was carried out at various temperature: 40^0C, 60^0C, 80^0C, 90^0C, and 95^0C as shown above. This type of graph is called a viscous stress graph

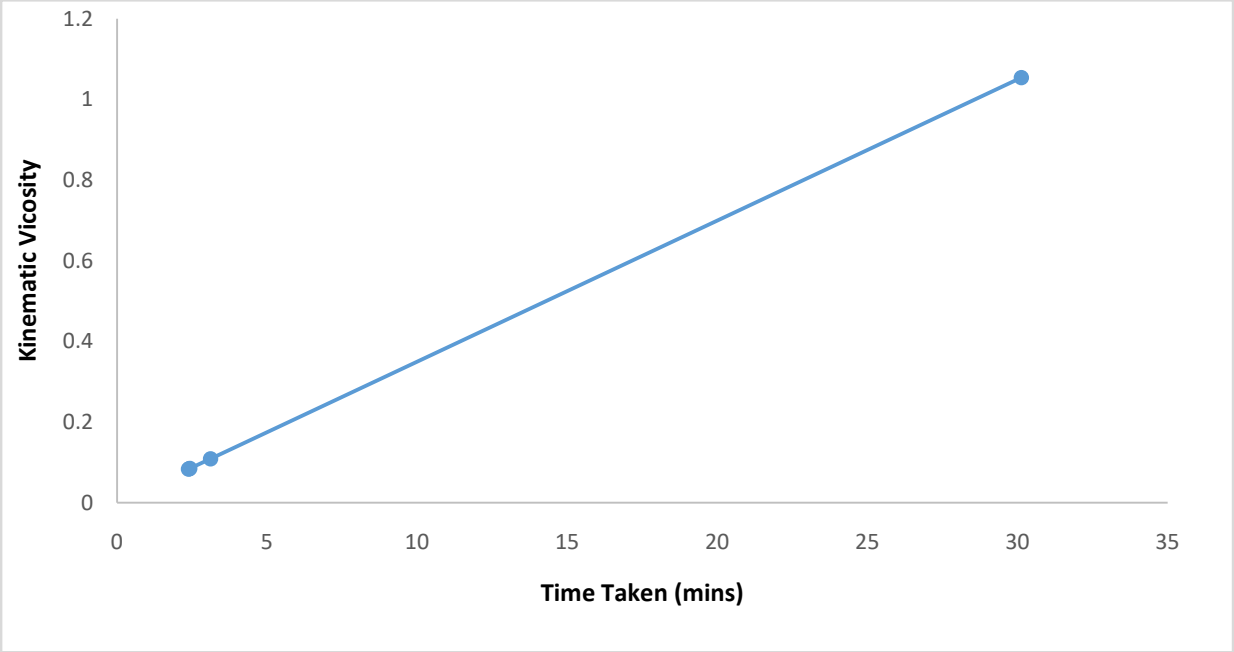

Fig 4.5: Graph showing the kinematic viscosity behavior of the seed oil against time

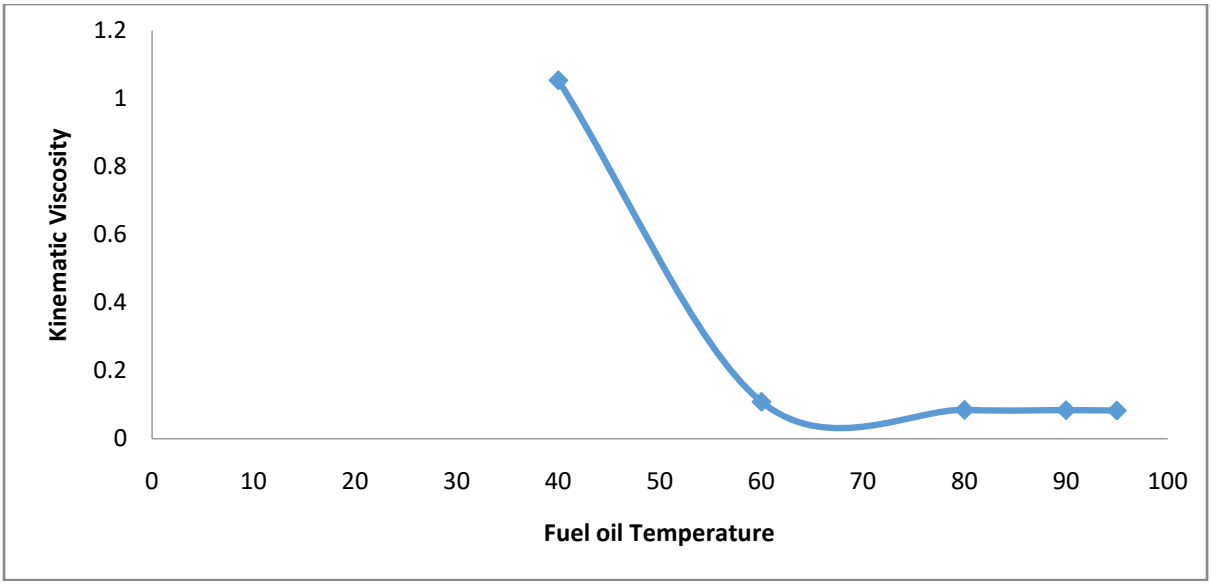

Fig 4.6, showing Kinematic Viscosity against Fuel Oil Temperature

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The pyrolysis of tallow seed to produce fuel oil increases with temperature. High yield is best obtained from 200°C. The fuel oil formation is also affected by the heat source and the size of condenser use to trap the vapour. The type of pyrolysis used for this research is a 'fast pyrolysis' due to the particle size of the grinded seed and shell. Thus, fast pyrolysis was initiated. The fuel oil produced contains fatty acid contents which can be used in soap making, lubricant for wood, leather and metal making industries. It can also be used as healing salve and skin balm because of its content; it contains conjugate linoleic acid which is a natural anti-inflammatory.

5.2 Recommendations

In order for the fuel oil from both the tallow seed oil and shell oil to be properly used, there should be further research on the chemical properties of the fuel oil. The fuel oil of both tallow seed oil and shell oil can be used most especially in Nigeria in various soap production industries and also for balm and skin care production because of its fatty acid content.

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