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# BIODIESEL PRODUCTION FROM *JATROPHA CURCAS* L.

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## ABSTRACT

Biodiesel, a promising substitute as an alternative fuel source, was extracted, processed and purified at the University of Port Harcourt sourced from *Jatropha curcas*. The utilization of liquid fuels such as biodiesel produced from Jatropha oil by transesterification process represents one of the most promising options for the use of conventional fossil fuels. Using the soxhelet extraction Jatropha oil is extracted from the seeds of *Jatropha curcas.* The Jatropha oil is converted into jatropha oil methyl ester known as biodiesel prepared in the presence of homogeneous catalyst Potassium hydroxide (KOH). The physical properties such as density, flash point, Kinematic viscosity, Cloud point and Pour point were found out for Jatropha oil and Jatropha methyl ester. The same characteristics study was also carried out for the diesel fuel for obtaining the base line data for analysis. The values obtained from the Jatropha methyl ester is closely matched with the values of conventional diesel and can be used in the existing diesel engine without any modification.

**Keywords:** Biodiesel, *Jatropha Curcas*, Fossil Fuels, Transesterification, Extraction.

## I. INTRODUCTION

The name "Jatropha" is gotten from two Greek words "Jatros" meaning "food" and "trope" meaning "nutrition" which implies its medicinal uses. Jatropha belongs to the family (Euphorbiaceae) and subfamily (Acalyphoidceae) and include over 175 species. The origin of *Jatropha curcas* remains controversial as it can be found over a wide range of countries in Central and South America. It is a native of Central America but now grows naturally in most tropical areas of the world ([1,2.3.4]). *Jatropha curcas* is a perennial tree 3-7m in height. It maybe evergreen or deciduous, depending on the climate. It has a short tap root, robust laterals and many fine tertiary roots. The Stem is woody, erect, cylindrical, solid and branched. Branches are stout, green and semi woody. Leaves are palmate and have 5-7 shallow lobes and are arranged in alternates with spiral phyllotaxis. The length and width of the tree varies from 16-21 cm and 14-18 cm respectively and are cailine and ramel, ex-stipulate, petiolate. Petioles are 12-19 cm long. Venation is multicostate, reticulate and divergent type ([2,5]). The Flowers of *Jatropha curcas* are unisexual. Fully flowering genotype exists, which creates the opportunity of creating pure hybrids varieties. Fruits are broadly ellipsoid capsules smooth-skinned, initially fleshy and green, turning yellow and eventually fry black and are 3 seeded. Seed are ellipsoid, 1-2 cm long mottled black and coarsely pitted. Seedling form a taproot and 4 peripherial roots. Depending on environmental circumstances; humid and warm settings favour crop growth and development. The exocarp remains fleshy until the seeds become mature, finally separating into cocci. The fruit is 2.5-3.5 cm long 2 - 2.5cm wide. Seeds are black, oblong, 2.5-3 cm long and 1 cm thick, more or less spherical or ellipsoidal seed weight (10 seeds) ranges from 53 -77g which contains 13.06 -42.42% oil content.

Bio-fuels are considered in part, a solution to such issues as sustainable development, energy security and a reduction of greenhouse gas emissions. Currently due to gradual depletion of world petroleum reserves and the impact of environmental pollution of increasing exhaust emissions, there is an urgent need to develop alternative energy resources, such as bio-fuel. Vegetable oil is a promising alternative because it has several advantage, it is renewable, environ-friendly and produced easily in rural areas, where there is an acute need for modern forms of energy. Therefore, in recent years several research have been studied to use vegetable oils as fuel in engines as bio-diesel. [6]. Furthermore, vegetable oil-based products hold great potential for stimulating rural economic development because farmers would benefit from increased demand for vegetable oils. Various vegetable oils, including palm oil, jatropha oil, soybean oil, sunflower oil, and canola oil have been used to produce bio-diesel fuel and lubricants. [7]

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## II. METHODOLOGY

### 2.0 SOURCE OF MATERIAL

*The Jatropha curcas* seeds were sourced from Wokoma Street Choba Port Harcourt and Ibadan, Ogun State Nigeria. The apparatus used in the production were sourced from the Department of Plant Science and Biotechnology University of Port Harcourt and Tencharis research Laboratory Port Harcourt, Rivers state.

### 2.1. MATERIALS USED

Soxhlet extractor (Mettler Toledo), Methanol, A sensitive weighing balance- weighing accurately 0.1grams, preferably less-0.01grams, Oven, Glass distiller, Dry blender, Thermometer, Hot plate, *Jactropha curcas* oil, Glass containers, Potassium hydroxide (KOH), Distilled water, Beakers and a Wash bottle.

### 2.2 PROCESSING OF SEEDS

The *Jatropha curcas* seeds used for biodiesel production were removed from their bark and properly washed and dried. After drying for a day, the seeds were then grinded with a dry blender to an almost smooth texture.

### 2.3 EXTRACTION OF OIL WITH SOXHLET EXTRACTOR

Oil extraction was carried out using a soxhlet extractor. It is an apparatus used in the extraction of oil from substances using various solvents. The *Jatropha curcas* soil was extracted from the blended seeds using 98% Acetone. The grinded seeds were packed into pockets of filter papers and then inserted into the soxhlet extractor with the extraction solvent (98% Acetone). At about 24 hours of extraction, 350ml of oil were produced from 1.3kg of the *Jatropha curcas* seeds.

### 2.4. PURIFICATION OF OIL

The oil from the *Jatropha curcas* were first filtered to remove impurities and were later boiled over a hot plate to evaporate excess water that might be present in the oil sample. Water present in the oil will interfere with the sodium hydroxide needed to neutralize the free fatty acid thereby resulting in a jelly.

### 2.5. TRANSESTERIFICATION (BIODIESEL FORMATION)

1. The reactants were measured: 200ml of filtered turmeric oil was poured into a 400ml beaker, 200m1 of 99.8% methanol into a 400ml beaker, and 4.9g of 85% potassium hydroxide (KOH) onto a 50ml beaker.
2. The 4.9g potassium hydroxide was then poured into the 200ml methanol.
3. The solution was stirred with a glass rod and swirled for about 10mins to dissolve KOH, during the process, heat was generated as a result of the reaction.
4. The methanol was mixed with the potassium hydroxide to give potassium methoxide solution, a strong base.
5. The *Jatropha curcas* oil was pre-heated to $60^{0}$C.
6. 100ml of the Methoxide solution were measured out into a beaker.
7. The 100ml methoxide were then poured into the 200ml of *Jatropha curcas* oil in a 400ml beaker
8. The beaker were shaken vigorously for 20 - 30mins and allowed to settle.
9. The mixture was left to settle for 24 hours to allow proper separation of Methyl Esters and glycerines.

### 2.6. SEPARATION

Once the reaction was completed, the major products were generated: glycerines and biodiesel. Each had a substantial amount of the excess methanol that were used in the reaction. Settling took about 8 hours. 75% of the separation occurred within the first hour after the reaction. The glycerines phase was much denser than biodiesel phase. Within 8 hours, the glycerines settled at the bottom and methyl esters (biodiesel) at the top. Biodiesel was separated from glycerine by decanting.

### 2.7. METHYL ESTER WASH BY SWIRLING

The method used were that of ([8]). The biodiesel were purified by washing gently with warm distilled water to remove the residual catalyst or soaps, dried, and sent to storage. This marked the end of the production process resulting in a clear amber-yellow liquid with a viscosity similar to biodiesel. In some systems the biodiesel is distilled in an additional step to remove small amounts of colour bodies to produce a colourless biodiesel. The methyl ester were poured into a separate clean container, so it can be washed free of any remaining soaps, salts, or free fatty acids.

**Steps involved as follows:** Water was added to the methyl ester (biodiesel) and stirred, and then the mix were allowed to settle. When the water had clearly separated from the methyl esters, it were drained or pumped out. This procedure was repeated until the discarded rinse water reached pH level of 6 – 7 and no soap bubbles appeared. When the liquid was cloudy, it meant that there was water being retained in the fuel, and it was

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heated slowly to evaporate out the water. Any white substances forming at the bottom or any bubbles forming at the surface were a sign of soaps and were removed by re-washing the fuel. The most important aspect of biodiesel production to ensure trouble free operation in diesel engines, that is; Complete Reaction, Removal of Glycerine, Removal of Catalyst, Removal of Alcohol and Absence of Free Fatty Acids and water.

**2.8. PRECAUTIONS**

Safety equipment such as chemical-proof gloves, eye goggles, nose masks and a lab coat should be worn during the experiment for safety. It is important to note that Methanol is explosive when it reacts with air. Therefore, it is a good idea to have a fire extinguisher around that is capable of putting out an oil based fire. Do not work in a closed system to avoid explosion and Biodiesel should always be made in a well- ventilated area away from children and pets. Avoid inhaling the chemicals and when making biodiesel, it is important to be safe. Most of the reactants are toxic chemicals, the potential to be seriously hurt, injured, or even kill oneself and others exists. [9]

## III. RESULTS AND DISCUSSION

**Plate 3.1.** J. curcas bearing fruits

**Plate 3.2.** Dried J. curcas seeds

**Plate 3.3.** Blended J. curcas seeds

**Plate 3.4** oil separation process

**Plate 3.5** separated biodiesel

**Plate 3.6.** Pure biodiesel

Biodiesel production from *Jatropha curcas* was optimized using methanol and potassium hydroxide (KOH) in a trans-estrification process. This produced biodiesel in consonance with the work of ([10]) who did a similar investigation on biodiesel with *Jatropha curcas* oil using methanol and potassium hydroxide (KOH).

## IV. CONCLUSION

The trans- esterification works well when the input oil (*Jatropha curcas* oil) is of high quality, that is, when the oil contains less free fatty acids (FFA).

In cases where the FFA content of the oil is above 1%, difficulties arise and results in the formation of soap. If the FFA content is above 2%, the process becomes unworkable. Therefore, in this work, the major concentration laid towards the most favourable parameters, that is the KOH and methanol used in right proportions that can support optimum production of biodiesel from *Jatropha curcas* fruits.

Also the production of biodiesel from *Jatropha curcas* and other feedstock could serve as an alternative to fossil fuel as it is eco friendly and helps reduce the dependence on petrol-diesel and simultaneously creating jobs and ensuring sustainable energy systems in Nigeria.

## V. RECOMMENDATION

The properties of *Jatropha curcas* L. has attracted a lot of projects developers. At present, many countries have started cultivating *Jatropha curcas* trees on large scale, although little is known about the positive and negative effects of the large scale production of *Jatropha curcas* on ecology as well as other socio-economic situations. There is need to research on the life cycle analysis (LCA) for the biodiesel production from *Jatropha curcas* at small scale and industrial production units particularly in developing countries where there is large scale production of *Jatropha curcas*. The LCA studies will result in data on the energy balance, the greenhouse gas balance and the land use impact (soil, water, vegetation structure and biodiversity) of the *Jatropha curcas* in Biodiesel systems. There is also a dearth of indisputable scientific information on its potential yield under suboptimal land marginal conditions, causing difficulty in predicting yields in future plantations under sub-optimal conditions, the conditions where *Jatropha* is supposed to prove its value. There is need to investigate an appropriate method for the trans-esterification (with regard to the appropriate catalyst and other variables that affect the trans-esterification process) of crude *Jatropha curcas* oil.

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