NIPES

Journal of Science and Technology Research

Journal homepage: www.nipesjournals.org.ng

Biolubricants Exploration as an Alternative to Petroleum Based Lubricants and its Prospects in Nigeria

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Article Info

***Keywords*:**
Biolubricant, Petroleum, feedstocks, Reneweable fuel, Lubrications, Prospect,

Received 03 April 2022
Revised 09 May 2022
Accepted 17 May 2022
Available online 10 June 2022

doi Crossref NIPES JOURNALS

https://doi.org/10.37933/nipes.e/4.2.2022.5

https://nipesjournals.org.ng

Abstract

Biolubricant applications are presently limited in comparison to mineral oils in Nigeria. However, this trend is growing and is dependent on investment in research and development. The rise in demand for biodegradable lubricants is linked to the evolution of environmental regulations, which have become more stringent in order to reduce the environmental impact of improper disposal of petroleum based lubricants. This paper presents an overview of biolubricants, its properties, and advantages over petroleum based lubricants. This paper also provides trend of work progression on the search for viable biolubricants in Nigeria as well as its prospects. A thorough understanding of the properties of edible and non-edible seed oil can aid in identifying areas that require development so that the oil can be used as a lubricant base stock. From the survey of literature, more work has been done on biolubricants production from jatropha compared to other seed oil. To improve reactions like epoxidation and hydrogenation, the conversion of triglycerides to esters might be followed or preceded by one or more reactions. Biolubricant production from edible and non-edible seed oil has potentials to reduced unemployment by investing in the cultivation and processing of the oil. Vegetable seeds, both non-edible and edible, have the ability to generate economic benefits both locally and nationally. The development of new-generation heavy-duty lubricants will meet industry need for lubricated automotive equipment that reduces environmental burden by lowering emissions and achieving non-toxicity and biodegradability.

Government spending on research and development and product innovation should be enhanced following the implementation of legislation. Finally, biolubricants reduce system maintenance costs, improve competitiveness, and contribute to a healthier environment. Full exploration of environmentally friendly lubricant kinds is urgently required.

1.0.Introduction

Due to the depletion of fossil fuels and other environmental problems, the use of bio-materials has increased. As a result of the development of environmentally acceptable, renewable, and biodegradable industrial fluids like biolubricant, natural oils and fats are now widely used for non-edible uses. Biomass is a renewable source of energy and chemical products, it is currently the only alternative among renewable energy sources capable of replacing petroleum in the production of a wide range of valuable organic products. A lubricant is a substance that is used to reduce abrasion and wear by forming a protective thin layer between two relatively moving surfaces [1]. All lubricants that are easily biodegradable and non-toxic to humans and the environment are referred to as biolubricants [2]. .Various plant and animal-based raw materials, such as jatropha seed oil, mango seed oil, soy bean, palm, tallow, and lard, are examples of biolubricant sources [3]. Plant oils, on the other hand, are superior in terms of biodegradability, particularly when compared to fossil oils [4]. Plant oil-based lubricants and derivatives are being researched as a base oil for lubricants and multifunctional fluids due to their exceptional lubricity and good biocompatibility [3].The use bio-substances had been at the growth trend because of depletion of fossils fuels and environmental factors. Hence, improvement of environmentally friendly, renewable and biodegradable commercial fluids such as biolubricant, has resulted in the enormous use of herbal oils and fat for non-fit for human consumption purposes. Sources of biolubricant consists of numerous flora and animals-primarily based totally uncooked substances including jatropha seed oil, mango seed oil, soy bean, palm, tallow, lard etc[9]. However, plant oils are advanced in phrases of biodegradability, particularly whilst in comparison to fossils oils [5] .Plant oil-primarily based totally lubricants and derivatives have high-quality lubricity and biodegradability, for which they're being investigated as a base inventory for lubricants and useful fluids [6]. However, the increase of green chemistry, the regulatory environment, research and developments account for the increased uses of bio-lubricants in the long run [4]. About 30-40 million tons of lubricants are produced per annum with Petroleum-based lubricants, often known as mineral oil, accounting for over 95% of total lubricant manufacturing [2]. They also reported that 50–75 percent of total lubricant produced are released into the environment unintentionally. Thus these oils are made up of a complex blend of 20 to 50 hydrocarbon carbon atoms which are non-renewable, highly toxics and non-biodegradable hence pose environmental dangers. The increasing human population of Nigeria is imposing high demand of transportation fuels from fossil sources thereby causing environmental pollution hence there is need to use a biobased fuels that are eco-friendly as an alternatives for automobile lubricating oil. According to MarketWatch.com.2021, Nigeria's lubricant market is predicted to reach 339.52 kilo tons by 2026, with a CAGR of 1.54 percent [5] . The growing demand for high-performance lubricants, as well as demand from the burgeoning wind energy sector, are the main reasons driving the market's expansion [5]. Based on their report, the most dominant end-user industry in the market is automotive and other transportation. According to the report of Liquefied Natural Gas,(LNG,2021), Nigerian lubricants market grew at an anticipated 10% per year before peaking at 450,000 metric tons in 2015 [7]. However, Nigerian Lubricant Producers Association reported that there was in a decline in production to 400,000 tons (LUPAN) (LNG, 2021). According to the Lubricants Producers Association of Nigeria (LUPAN) report, Nigeria's lubricant market demand volume reached 600,000 metric tons in 2019, accounting for around 20% of Africa's overall lubricant demand. Based on the report of researchAndMarket.com, the Nigerian lubricants market grew from 2012 to 2017 owing to a rise in the number used or new vehicles in the country. They also reported that older vehicles needs more regular lubricant changes than newer ones, which attributed to the volume demand for automotive lubricants in Nigeria [6].

Nigeria is completely reliant on imported base oils despite having Africa's greatest crude output. The country's lone base oil unit, at a Nigerian National Petroleum Company refinery in Kaduna, was destroyed by fire in 1996 and has remained closed ever since, despite pledges from successive governments to reopen it. Also according to Nigeria's New Telegraph newspaper 2021, the economic loss is expected to be more than $61 million dollars. Based on the report of Department of Petroleum Resources (DPR), the Kaduna Refining and Petrochemical Company (KRPC) was the only refinery designed to produce Base Oils, Asphalt (Bitumen), and Waxes; however, the refinery's quasi has left the country primarily reliant on importation. According to DPR data, the country has roughly 34 lubricant blending plants with a total storage capacity of 120.57 million litres of base oil. To meet market demand, local blending factories now rely primarily on importation of feedstock and reuse of base oils [7]. According to their report, shortage of base oil has caused charge increment from N850 to approximately N2000 consistent with litre and the fashion is probably to stay until the cease of 2021. This has caused upward push within the fee of servicing cars in addition to plant and machinery. The total amount of base oil imported into the country was 264.4 million litres per year [8]. The price of these biolubricants when compared to a conventional lubricant, a biolubricant cost increases around 30 and 40% higher. However, it has the potential to minimize power consumption and engine wear, and perhaps some biolubricants' performance is already comparable to that of petroleum-based lubricants [6]. They provide even superior efficiency in certain applications, such as hydraulics, than petrochemical-based lubricants. A growing interest in evaluating the impact of lubricating oils on the environment and human health encourages research centers and industry to develop innovative methods for the production of entirely biodegradable, natural-source lubricating oils. In this study, we have reviewed the available literature and recently published data related to bio-lubricants and it’s based raw materials in Nigeria with details presented in Table 2. Additionally, we have analyzed the impacts and benefits of the use of bio-based raw materials as functional fluids or biolubricant and projected its furture prospect in Nigeria as an alternative to petroleum based oil.

1.2 Biolubricants from Global Perspective

About 30-40 million tons of lubricants are produced per annum with Petroleum-based lubricants, often known as mineral oil, accounting for over 95% of total lubricant manufacturing[2]. They also reported that 50–75 percent of total lubricant produced are released into the environment unintentionally. Thus these oils are made up of a complex blend of 20 to 50 hydrocarbon carbon atoms which are non-renewable, highly toxics and non-biodegradable hence pose environmental dangers. In 2015, the worldwide biolubricants market demand was predicted to be around 630 kilo tons, and by 2024, it is expected to be 1,115 kilo tons, increasing at a 6.9% CAGR from 2016 to 2024. A key element driving demand for improved biolubricants in automotive applications is their increasing cost competitiveness, particularly in light of anticipated high crude oil costs [7]. Automotive engine oils were the most popular application sector in 2015, with over 200 kilo tons of demand. The market is anticipated to increase due to technological advancements that improve the oxidation resistance and usefulness of vegetable oils. In 2015, North America was the greatest consumer, with sales of USD 742.5 million. In comparison to other regions such as Asia Pacific, Latin America, and the Middle East, the area is technologically advanced [6].

Around 1700 minor and major lubricant producers are known to have existed globally. Around 300 of them manufacturers are based in Europe. In addition, Europe has 380 blending and packaging enterprises. These are vertically integrated petroleum businesses (Exxon Mobil, Shell, Castrol, BP, and others) that specialize in the exploration, refining, and extraction of crude petroleum oil. Approximately 1,200 self-governing lubricant firms focus on making and selling [6]. Lubricants also finds application in the formulation of products likes gear oils, transmission oils, and hydraulic oils, among other applications [1].

Table 1: The major manufacturer of biolubricants and their region [6].

MANUFACTURER	REGION
Shell	Great Britain/The Netherlands
Exxon Mobil	United State of America
BP	United Kingdom
Chevron	United State of America
Petro	CHINA
Lukoil	RUSSIA
Nippon Oil	Japan
Valvoline	USA
Indian Oil	India

No company from African and Nigeria produces biolubricants hence the need to intensify research for the production despite the huge resources of petroleum in Nigeria hence there is need to intensify effort towards producing this environmentally friendly products that are gaining interest around the word. Figure 1 below shows the global consumption of lubricant based on region

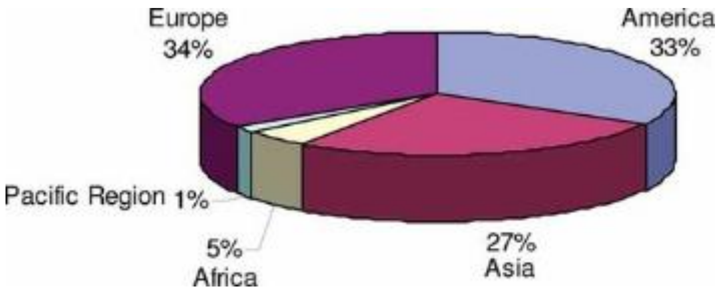

Figure 1: Worldwide consumption of lubricants [3]

The size of the global lubricant market, which shows that Europe, America, and Asia consume almost one-third of all lubricants. Between 13 and 32 percent of all used lubricants return to the environment with changed physical properties and appearances (EC nations).Hence, lubricants must be manufactured, used, and disposed of in a manner that ensures the best possible protection of the environment and, in particular, living beings. Bio-lubricants are a tiny but growing sector that, if performance is comparable, might be a viable alternative to mineral-based oils [4].

1.3 Concept of Lubricants and Bio-Lubricants

Lubricant is a substance introduced to reduce friction between moving surfaces. It may also have the function of transporting foreign particles [9]. Lubricating oil is regarded as a structural fluid in machinery and devices. Its primary function is to create a layer in the form of a microfilm between the device's moving elements. Lubricating oil can perform a variety of activities during operation, including reducing friction, eliminating scuffing of rubbing machine elements, washing carbon deposits and micro particles, anti-corrosion, cooling, and other impacts [10]. Lubricants are typically made up of a majority of basic oil and a range of additives to give them desirable properties.

1.4 Classification of Lubricants

Lubricants can be classified based on physical appearance, applications and feedstock (sources of based oil). Based on physical appearance, lubricants can be further categorized into three. These are;

A. **Solid lubricants** refer to a thin layer lubricants with components such as molybdenum disulphide, graphite, disulphide and cadmium usually made of carbon based or mineral compounds [1].
B. **The semi-solid-liquid lubricants** on the other hand are drifted in a solid medium of additives with the thickener. Example of semi-solid-liquid lubricants is grease [9].

C. **Liquid lubricants** are obtain from plants, synthetic, animal and petroleum sources. On the basis of applications, lubricants can be classified as industrial lubricants, automotive lubricants and special purpose lubricants [10].

   i. **The industrial lubricants** mainly consist of hydraulic oils, compressor oils, metal-working fluid and machine oils that are used in the industries while
   ii. **The automotive lubricants** includes brake oil, transmission fluids, hydraulic fluids, engine oils and gearbox oils which are all used in the vehicle and transportation industries whereas
   iii. **The special purpose lubricants** such as process oils, instrumental oils and white oils, re examples of special lubricants utilized for specialized purposes and operations [1].

The last classification of lubricant is on the basis of feedstocks (sources of base oil) or chemical composition and in this case, lubricants can be further classified into three which are natural lubricants, synthetic lubricants and refined lubricants.

1. **Natural lubricants** involves lubricants derived from natural sources such as plant and animal origin. They are mostly obtained from vegetable oils or animal fats and they are unstable at high temperatures and create chemicals that are damaging to machinery and equipment. These oils are more readily available, less expensive, and have a better biodegradability than petroleum based lubricants oils [11].
2. **The synthetic lubricants**: This uses the natural oils as starting materials to create more advanced biolubricants. They are made from end products of custom-made processes. Examples include silicones, polyalphaolefines, and synthetic esters. Chemical processes produce synthetic oils, which are the greatest lubricants for demanding applications. They're made from vegetable oils in a variety of ways, the most common being straight or branched-chain monoesters, diesters, triesters, and polyol esters [2]
3. **The refined lubricants** are made from petroleum resources like aromatics, naphthenic and paraffinic oil [11].

1.5 Biolubricants: These are mainly lubricants obtain from triglyceride esters obtained from plants and animals. However, plant derived materials such as jatropha oil, castor oil, moringa oil, Neem seed oil, cotton seed oil etc are preferred due to their properties which enhanced green fuels and the facts that they are not edibble hence, they don’t compete with food crops [12]. Bio-lubricants provide both environmental and health benefits over petroleum-based lubricants. Most importantly, biolubricants refer to all lubricants, which are both rapidly biodegradable and non-toxic to humans and environments. Biolubricant is one of the most potential applications of branched fatty acid. Biolubricant could be prepared with esterification of free fatty acids, which is usually obtained over alkaline catalyst in industrial scale [13]. Biolubricants is synthesized mostly from vegetable oil by a cleavage of alcohol group in polyol and replaced by fatty acids derived from methyl esters according to Figure 2.

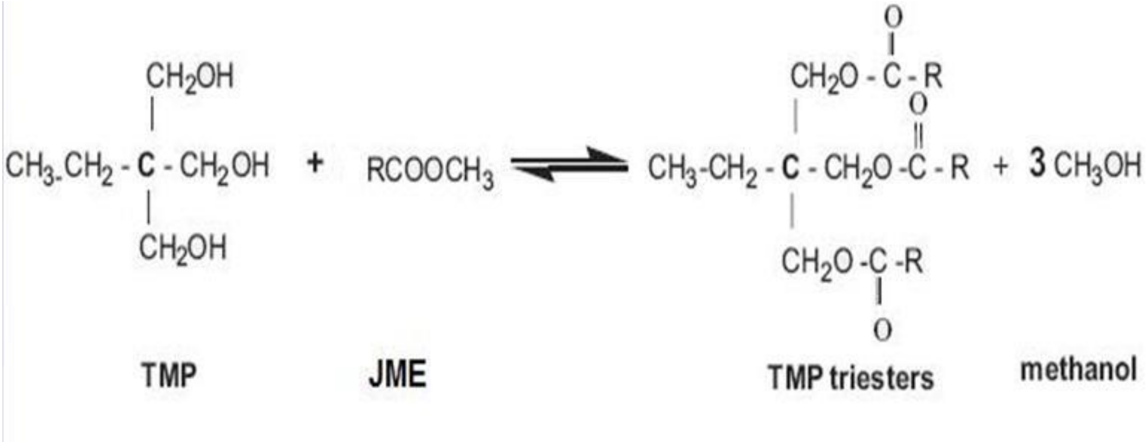

Figure 2: Reaction for production of biolubricants [9]

Figure 2 describe the transesterification of jatropha methyl ester (JME) with common polyol trimethylolpropane (TMP) produced the TMP based ester which exhibits improved temperature properties [9]. Timothy et al. [14] stated that Vegetable oils are preferred as alternatives to mineral oils for lubricant base oils because of their inherent properties and their ability to be biodegradable. Vegetable oil used for production of biolubricants can be edible or non- edible, thus, various countries can be a producer of biolubricants.

Classification of biolubricants: Biolubricants can be classified according to their chemical composition as natural and synthetic oils [2].

Natural biolubricant: These are made from vegetable oil, seeds and fruits of a plant and sometimes animal fat. This type of lubricant is obtained purely without any blend. They are obtained from cheap, highly biodegradable sources and mostly non-edible seed such as jatropha seed oil, Neem seed oil, castor seed oil etc.

Synthetic biolubricant: This class of biolubricant is obtained from chemical modification of plant based oil with animal fats.i.e a blend of plant based oil with petroleum based lubricant to enhance their lubricity. Also, according to International Standards Organization (ISO), biolubricants are classified on the basis of their viscosity grades as ISOVG32, ISOVG46, ISOVG68 and ISOVG100 [13].

1.6 Characteristics of Biolubricants

From the survey of literature, the following characteristics were collated:

1. **Biodegradation**: It is the process by which organic substances are broken down by the enzymes produced by living organisms. Biodegradation is the chemical transformation of a substance by organisms or their enzymes [14].

2. **Viscosities**: The viscosities of the biolubricant at 40 and 100 degrees Celsius are essential lubricity parameters that can be used to determine the lubricant's fluidity at low and high temperatures. They also reveal the lubricant's heat stability [15].

3. **Pour point**: The lowest temperature at which oil flows when its container is tilted for a set amount of time is called the pour point. It's necessary for oils that have to flow at low temperatures. It is one of the most important characteristics that determines the lubricants' performance [9].

4. **Biodegradability and Toxicity**: The fundamental reason for replacing mineral oil-based lubricants with bio-lubricants is because they are regarded as environmentally acceptable meaning they have little detrimental influence on the environment [4].

5. **Toxicity**: Toxicity of lubricants is another significant factor to consider when designing a bio-lubricant, and labeling programs have toxicity criteria as well. To determine toxicity, multiple different tests are available, and several separate tests must be done in order to acquire a thorough understanding of a substance's toxicity on various organisms [2].

6. **Oxidation:** The oxidation of lubricants is a type of chemical degradation produced by the reaction of the lubricant with oxygen from the air or moisture. Metallic wear debris, as well as rising temperatures, can act as catalysts for this process. Due to the commencement of polymerisation [16] and the creation of short chain fatty acids, oxidation produces an increase in viscosity; these oxidation products can form deposits [17].

7. **Viscosity Index and Shear Stability**: The Viscosity Index (VI) is a measurement of a lubricant's viscosity variation as a function of temperature. This number is calculated by comparing the viscosity of the lubricant at 40 and 100 degrees Celsius. The VI of two reference oils is then compared to the VI of the viscosity values [18]. The greater the VI value, the more temperature-dependent the viscosity is Because lubricant applications frequently operate over a large temperature range, the VI is a significant metric. Because to their long chained fatty acid structure and lack of aromatics, bio-based lubricants have a higher VI than mineral oil [17]. Shear stability refers to a lubricant's capacity to resist viscosity changes under mechanical stress.

8. **Flash point:** The flash point of a lubricant is the lowest temperature at which it will ignite but not burn [17]. Because vegetable oils contain longer carbon chains, they have higher flash points, which is advantageous in combustion engines because lubricants are less likely to be lost during combustion.

9. **Solvency:** The capacity of a lubricant to react with other substances, such as additives or wear debris, is known as solvency. The key deciding factor is the polarity of the base stock. It's crucial to think about because additives need to be distributed evenly to be effective. To decrease further wear caused by wear debris particles, a base stock's capacity to move wear debris away from a contact is also critical [17].

1.7 Advantages of Biolubricants Over Petroleum Based Lubricants

The favorable regulatory environment is likely to boost the manufacture and use of bio-based lubricants and to use environmentally friendly, approved lubricants in all oil-to-sea interfaces.

The need for vegetable and plant-based lubricants is being driven by many environmental problems connected with petroleum based lubricants as illustrated in Figure 3 and Figure 4 respectively. One strategy to lessen the negative impact of lubricants on the environment is to replace hydrocarbon-based oils with biodegradable products. The use of low or no sulfur, low ash, and phosphorous (low SAP) esters- or polyglycol-based oils (as alternatives for hydrocarbon-based oils in passenger cars) necessitates the development of a lubricant composition with equivalent tribological and functional qualities[1]. Biolubricants have a variety of uses. Because of their superior inherent qualities, biolubricants prove advantageous as alternative lubricants for industrial and maintenance applications. Due to their environmental advantages, biolubricants can be utilized in sensitive locations and reduce contamination. A lot of researchers have emphasized these benefits [19] like cost savings, lesser maintenance cost, sustainability and biodegradability.

Figure 3:Site of used engine oil [20].

Figure 4: Used engine oil dumping site [20]

Figures 3 and 4, shows a typical environmental damages or consequence of petroleum based lubricant at a location in Nigeria. This contaminant are not biodegradable, highly toxic and as such contains heavy metals such as lead, Cadmium, Zinc etc which are poisonous to human. Also, this causes water and soil pollution hence dangerous to both human and the environment. Biolubricants offer potential advantage over petroleum based lubricants as it display excellent and better characteristics of lubricants than petroleum based lubricants hence, biolubricants is considered renewable and readily biodegradable.

According to Juan et al [2], biolubricants present high lubricity, good metal adherence, and a high viscosity index. In their work, they Summarizes the advantages of biolubricants over petroleum based lubricants as follows:

a) Higher boiling point (less emissions)
b) Lower volatility
c) Higher viscosity index
d) Higher biodegradability (free of aromatics)
e) Higher lubricity
f) Higher safety on shop floor
g) Better skin compatibility
h) Higher shear stability
i) Higher tool life

2.0. Trends of Work Progression on the Search for Viable Biolubricants

The survey of works done so far in Literature are presented in Table 2.

Table 2: Some of the reported work on lubricants production in Nigeria

Author	Feedstock/ raw material used	Study approach	Type of lubricant produced	OBJECTIVES	Remarks/KEY FINDINGS
[21]	Palm kernel oil (PKO)	Conventional method ,epoxidation and	Biolubricants	To synthesized and characterized of palm kernel oil (PKO) for biolubricant production using transesterification of	Biolubricants was produced from palm kernel oil

		esterification)(transesterification		palm kernel methyl ester with trimethylolpropane (TMP) and epoxidation-esterification methods.	
[15]	Jatropha seed oil	Conventional method transesterification process,	Biolubricants	To investigate the feasibility of producing biolubricant from Jatropha oil by conducting chemical modifications on the Jatropha crude oil.	Produced biolubricant from the Nigeria jatropha oil through a two-step transesterification process using ethylene glycol.
[22]	Castor oil	Conventional method transesterification process,	Biolubricants	To produce biolubricants from castor oil	They produced biolubricants from castor oil
[19]	Palm Kernel Seed Oil and plantain peeling	Conventional method transesterification process,	Biolubricants	To synthesized biolubricants from Cameroon palm kernel seed oil by double transesterification	Biolubricant was produced and characterized.
[9]	Vegetable oil such as castor oil, moringa oil, Jatropha oil	Conventional method transesterification process,	Biolubricants	To produce biolubricant from vegetable oils.	Physic-chemical determination and chemical modification of the produced biolubricant in order to enhance their suitability for ISO viscosity grades requirement was also determined.
[23]	Jatropha curcas specie seed oil	Conventional method transesterification process,	Biolubricants	To investigate the use of Nigerian Jatropha oil as a feedstock for the production of biolubricants in a two-step base catalyzed reaction of Jatropha oil methyl ester (JME) with trimethylolpropane (TMP).	Biolubricant was produced from jatropha seed oil, characterized and compared with ISO standard.
[24]	African star apple) fruit seed (Chrysophyllum Albidum Seed) Oil	Conventional method Esterification	Synthetic lubricants	Syntheses and characterization of bio-lubricant from modified oils of *chrysophyllum albidum* (African star apple) seeds to reduce the effects of environmental impact of waste generated from drilling operations.	Bio-lubricants were made from non-edible low-cost vegetable oils derived from waste chrysophyllum albidum seeds in Nigeria.
[8]	Used engine oil	Statistical method	petroleum based lubricants	To gather information in the African region using Nigeria as a case study, to better define a strategy for the management of used oils in Africa.	They investigate the impact of petroleum based lubricants in Nigeria.
[25]	*Moringa oleifera* Oil	Blending of moringa oil with conventional lubricants	Biolubricants	moringa oil based biolubricants was developed and the densities, viscosity and wear rate studied to assert its compatibility for industrial application.	Moringa oil was used to produce biolubricant and compared with standard.

[26]	Jatropha curcas seed oil	Statistical Optimization	Biolubricants	To carry out statistical Optimization of Biolubricant Production from Jatropha Curcas Oil using Trimethylolpropane as a Polyol	They carried out optimization of process conditions for production of biolubricant from Nigeria jatropha oil and Trimethylolpropane.
[27]	Neem seed oil	Conventional method	Biolubricants	To assessed the influence of formulated Neem seed oil and jatropha curcas seed oil on wire drawing of mild steel and medium carbon steel at elevated temperatures,	Carried out studies on Crude Jatropha oil as a basestock for industrial lubricant production
[28]	Jatropha curcas seed oil	Conventional (Transesterification)	Biolubricants	To produced biolubricant from Jatropha seed oil	Studied the lubricant properties of Nigeria Jatropha oil mechanically extracted using four ball tester.
[20]	Mineral oil	Disposal of used lubricants and its management/control	Petroleum based lubricants	To evaluate and assessed Used-Oil Generation and Its Disposal along East-West Road, Port Harcourt Nigeria	They investigate the effect of indiscriminate disposal of used oil.
[29]	Vegetable Oils, Calabash seed oil with Mineral Based Lube Oil	Blending of Vegetable Oils with Mineral Based Lube Oil	Synthetic lubricants	To obtain blends of lubricating oils using vegetable oils and mineral based SAE 40 lube oil	They blend biolubricants with petroleum based lubricants in order to reduce consumption of mineral base oil and the associated environmental and health issues.
[14]	Jatropha oil	Conventional method (Transesterification, epoxidation)	Biolubricants	To presents detail study of Nigerian Jatropha oil properties with particular emphasis on the properties that are of lubrication importance.	study Nigerian Jatropha oil properties with particular emphasis on the properties that are of lubrication importance.
[30]	Jatropha seed oil	Conventional method (Transesterification)	Biolubricants	To produced and characterized biobased transformer oil from Jatropha curcas seed oil.	They produced transformer oil from jatropha oil and compared with the ASTM standard for use as transformer oil.

From several studies carried out with regards to production of biolubricants in Nigeria. (with details presented in Table 2). Most of the authors used jatropha as a based oil while non-consider the economic feasibility neither is there any one that carry out study on setting up pilot plant for biolubricant production in Nigeria. While the manufacturing of Jatropha oil biolubricant has been extensively carried out in Nigeria, more attention is needed to its optimization, economic feasibility, and application in terms of pilot plant study. Other prolific non-edible food crops, such as need seed oil, castor oil, cotton seed oil, and so on, should also be considered. Based on the work done thus far in Nigeria, little progress has been made in increasing the performance of bio-based lubricants; therefore, a thorough understanding of the oil's properties is critical to improve the oil's performance.

Furthermore, none of the studies in Table 2 consider fatty acid isomerization to be an essential avenue for biolubricant production, implying that solid catalysts, including isomerization catalysts, are needed to develop better isomerization catalysts. Finally, the government should fund research on biolubricants to see how they compare to petroleum-based lubricants. Nigeria has a lot of potential in terms of biolubricant production from edible and non-edible oilseeds. Only few ten varieties of oilseeds, such as Jatropha seed oil, and castor seed oil, have been detailed thus far, other like neem seed oil mango seed oil, flamboyant seed oil, soya seed oil, and fluted pumpkin seed oil etc should give more attention to establish their viability for biolubricant production.

2.1. Prospects of Biolubricant in Nigeria

Nigeria is currently importing edible oil [29] hence, with a rising population and an inability to meet domestic demand for edible oil, it is now exceedingly difficult to use edible oil for lubricant formulation. As a result, non-edible oil is should be more consider as an alternative for bio-lubricant development. The Nigerian jatropha oil is easily biodegradable, whereas the mineral oil-based SAE20W50 lubricant is not. As a result, Nigeria Jatropha oil provides a viable alternative to the search for a renewable, ecologically acceptable lubricant base stock. Biolubricant production from edible and non-edible seed oil has potentials to reduced unemployment by investing in the cultivation and processing of the oil. Nigeria focusing on the development of biolubricants can significantly reduce the country's outflow of foreign-currency revenues for lubricants. This will in turn allow Nigeria to increase its foreign exchange reserves. Vegetable seeds, both non-edible and edible, have the ability to generate economic benefits both locally and nationally. The development of new-generation heavy-duty lubricants will meet industry need for lubricated automotive equipment that reduces environmental burden by lowering emissions and achieving non-toxicity and biodegradability.

3.0 Conclusion

To present, most natural oil research has concentrated on determining the physicochemical properties of saturated and unsaturated fatty acids for use as green solvents in Nigeria. However, economic, feasibility studies, optimization, and pilot scale plant for biolubricant production from non-edible sources need to be focused on and the expectation of rising biolubricant demand must be matched by rapid biolubricant formulation development. The use of biolubricants is being driven by rising consumer awareness of the environment, dwindling crude oil sources, and other considerations. Government spending on research and development and product innovation should be enhanced following the implementation of legislation. Also, Governments must enact legislation that stimulates the production of non-edible oil crops. Governments must also take steps to develop lubricants that contain more bio components and are less degradable and toxic than mineral oils. Although biolubricants are still in their infancy, the trend is growing and is dependent on Nigerian investment in research and development. The scientific community should focus more on enhancing the efficiency of biolubricant synthesis procedures, particularly in the areas of pilot scale studies and the economic viability of establishing a biolubricant factory in Nigeria. Biolubricants have higher quality and longer lifespans than minerals, as well as a number of environmental advantages, however the high cost of synthetic oils with renewable bases in comparison to minerals limits future growth. However, technology capable of producing renewable lubricants at competitive pricing and in sufficient volume to acquire market share is still in short supply. Finally biolubricants reduce system maintenance costs, improve competitiveness, and contribute to a healthier environment. Full exploration of environmentally friendly lubricant kinds is urgently required.

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