



ORIGINAL RESEARCH ARTICLE

EVALUATION OF CORROSION INHIBITION, THERMO-OXIDATIVE STABILITY, AND BIODEGRADABILITY OF CASTOR OIL-BASED LUBRICANT

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ABSTRACT

Global lubricant demand is on the increase and the continual consumption of mineral oil-based lubricant has devastating environmental impact. Despite the identification of animal fat and vegetable oil as alternatives to mineral oil-based lubricants, there is concern about its sustainability due to the food-versus-lubricant debate. Thus, non-edible vegetable oil-based lubricant development has become a topical area of research. In this paper, the study of physicochemical, rheological, temperature, thermo-oxidative stability, corrosion inhibition and biodegradability properties of castor oil extracted from Nigerian grown castor bean seeds was conducted using standard test methods. The results show that castor oil has specific gravity of 0.955, free fatty acid value of 19.74 mg KOH/g, pH of 5.76, saponification value of 185.41 mg KOH/g and Iodine value of 92.1 gI<sub>2</sub>/100g oil. An assessment of the rheological and temperature properties of the castor oil gave kinematic viscosity at 40°C and 100°C as 280.6 cSt and 77.5 cSt respectively, viscosity index of 33.4, pour point of -23.2°C, cloud point of -12.4°C and flash point of 282°C. The peroxide value of the castor oil was 8.92 meq/Kg and it was of corrosion grade 0. The castor oil has higher viscosity at 40°C, lower viscosity index, and poor physicochemical properties compared to the SAE 20W50. The properties of the castor oil require improvement except its cold flow, flash point and corrosion inhibition properties. The castor oil is highly biodegradable while the SAE 20W50 has poor biodegradability. Therefore, castor oil conforms to ISO VG220 grade lubricant and qualifies to be called a biolubricant.

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1.0 Introduction

The global increase in industrialisation and technological advancement has given rise to increase in the demand for lubricants. Due to oil spills, volatility, total loss during application, improper disposal practices and poor waste oil disposal techniques, increased consumption of petroleum-based lubricants causes environmental pollution. Therefore, research into environmentally friendly alternatives to petroleum-based lubricants is growing. Animal fats and vegetable oils are now considered to be one of the best alternatives to petroleum oil for lubricant production (Woma et al., 2019a). Lubricants produced from plant-based oils and animal fats are called biolubricants.

The global biolubricant market has been experiencing rapid growth and in some parts of the world it is projected that in the next two decades biolubricant application will grow by 15 to 20 percent (Almasi et al., 2021 and Khan et al., 2022). Vegetable oil based biolubricants are made from either edible or non-edible vegetable oils. Some of the most researched biolubricants are made of oils extracted from sunflower, soybean,

rapeseed, coconut, palm, Karanja, castor and Jatropha seeds (Binfa *et al.*, 2015; Woma *et al.*, 2019b; Nuur and Widayat, 2018). Recently, alternative renewable lubricant base oils such as waste cooking and microalgal oils have also been studied for producing biolubricants (Farfan-Cabrera *et al.*, 2022; Hussein *et al.*, 2021).

Globally, People are most concerned about the sustainability of vegetable oil-based lubricants because of the competition between the food sectors and industrial lubricant sectors for available edible oil. This concern is refocusing biolubricant research towards non-edible seed oils (Ioan, 2002; Erhan *et al.*; 2006 and Bilal *et al.*; 2013). The non-edible oil crops could be cultivated in arid and harsh environments, thereby preventing direct competition with conventional edible oil-bearing food crops (Singh *et al.*, 2019). Some of the non-edible oil seed-bearing crops earlier studied for biolubricant production are Castor, Karanja, Jojoba, and Jatropha (Sabiu, 2013; Dibal *et al.*, 2017; Menkiti *et al.*, 2017; Sharma and Sachan, 2019; Woma *et al.*; 2019b; Al Jabri *et al.*, 2021;). Castor oil, a nonedible vegetable oil produced from the seeds of castor plant and is the earliest and one of the largely investigated oils for industrial and automotive lubrication (Brigham, 1993; Musa, *et al.*; 2015; Bhaumik and Pathak; 2016). It is produced from castor beans by mechanical and solvent extraction processes. The average oil content of a castor seed on the basis of dry weight is 50% (Brigham, 1993). The presence of ricinoleic acid a type of hydroxylated fatty acid, and the glycerol group in castor oil imparts toxicity -making castor oil indigestible and unhealthy for human consumption (Hong *et al.*, 2011). Further, the presence of about 90% ricinoleic acid, imparts an unusually high viscosity and density to castor oil (Silva *et al.*, 2013; Zainal *et al.*, 2018).

Castor oil is produced on a large scale in Brazil, China, and India; global castor oil production is reported to be 1.8 million tonnes (Rios *et al.*, 2020). Africa, including Nigeria, has a contribution of around 0.08Mt (FernandezMartinez and Velasco, 2011). Castor plant is very productive in most of the agricultural lands within Nigeria. The yield of castor seed in Nigeria is rated at between 950-1,500 kg/ha and virtually every part of Nigeria is suitable for castor plantation (Gana *et al.*, 2013; Gana *et al.*, 2014). Thus, there is a renewed interest in research into the lubrication properties of Nigerian grown castor oil. Despite the extensive research on castor oil as a biolubricant, there is a dearth of literature on the corrosion inhibition properties of castor oil as a biolubricant. Also, it is generally believed from literature that vegetable oils possess poor thermo-oxidative stability (Woma *et al.*; 2019a) however there is need to determine and document the thermo-oxidative stability of each particular vegetable oil. In this work, the corrosion inhibition, thermo-oxidative stability as well as the biodegradability of unrefined, mechanically extracted castor oil, from a local extractor in Kano state, Nigeria is studied and compared with those of high-quality commercial SAE 20W50 engine oil from a manufacturer in Kano state, Nigeria. Additionally, recently published report has benchmarked a criterion for classification of lubricants as biolubricant: for any lubricant to be qualified as bio-lubricant; the biobased carbon content and biodegradability of the lubricant need to be 25 and 60 %, respectively (Salih and Salimon, 2021; Khan *et al.*; 2022). In view of this new classification, this work would examine the biodegradability of castor oil produced from Nigerian grown castor plants.

## 2. Materials and Methods

The major materials used in this research were castor oil sourced from Agrienergy Kano, and a mineral oil-based multigrade commercially available lubricant SAE 20/W50 obtained from Amasco Kano, used as a control experiment. The castor oil was cold pressed and mechanically extracted from Nigerian grown castor bean seeds.

### 2.1 Determination of Physicochemical Properties of Castor Oil

The physicochemical properties (specific gravity, acid value, percentage free fatty acid, iodine value and pH value) of the castor oil and SAE 20W50 commercial mineral oil-based lubricant were analysed. Details of the analysis are reported in the following subsections.

#### 2.1.1 Determination of specific gravity and density

The density was measured according to the ASTM D1298 standard while the specific gravity was determined according to the ASTM D1217 standard. A 50ml SEDI-M pycnometer bottle was washed thoroughly with detergent, water and petroleum ether, it was then oven dried and weighed. The bottle was filled with distilled water and weighed, the bottle was then dried and filled with the oil sample and weighed again. From theory, the specific gravity is the mass of the oil weighed divided by the mass of water weighed and the density of the oil was equal to mass of the oil per unit volume.

### 2.1.2 Determination of pH of the oils

The pH values of the oils were measured using the REX pHS -25 model pH meter. The pH meter was first calibrated using a standard solution. The electrode of the pH meter was cleaned with distilled water after each reading before taking another reading.

### 2.1.3 Determination of saponification value of the vegetable oils

The alcoholic KOH was freshly prepared by dissolving KOH pellet in ethanol. More than 1g of oil was measured and poured into a conical flask. 25ml of the alcoholic KOH was added to it, a blank was also used. The sample was well covered and placed in an oven for 30minutes shaking it periodically, 1ml of phenolphthalein was added to the mixture and to the blank and titrated against 0.5M HCl to get the end point. The saponification value (SV) was calculated using equation (1)

$$SV = \frac{56.1(B-A)N}{W_{oil}} \quad 1$$

where; B= volume of standard ethanol potassium hydroxide used in blank titration; A= volume of standard ethanol potassium hydroxide used in titration with the oil; N= normality of standard acid; and  $W_{oil}$  = weight of oil used.

### 2.1.4 Determination of iodine value of the oils

The oil was poured into a small beaker; a small rod was added to it. Between 1 to 2g of the oil was weighed and poured into a glass-stopper bottle of about 250 ml capacity. 10ml of carbon tetrachloride was added to the oil to dissolve it. 20ml of Wij's solution was added and a stopper was inserted and allowed to stay in the dark for 30minutes. 15ml of potassium iodide solution (10%) and 100ml of water was introduced and the mixture was thoroughly mixed and titrated with 0.1M sodium thiosulphate solution using starch as indicator (titration = 'A'ml). A blank was also carried out at the same time starting with 10ml of carbon tetrachloride (titration = 'B'ml). The iodine value (IV) was calculated using the equation (2)

$$IV = \frac{0.1269(B-A)NX100}{W_{oil}} \quad 2$$

where B= volume of sodium thiosulphate used in blank titration. A= volume of sodium thiosulphate used in titration with oil. N= normality of sodium thiosulphate.  $W_{oil}$ = weight of oil used and 0.1269 is the iodine number.

### 2.1.5 Determination of acid value/ percentage Free Fatty Acid (%FFA)

The oil was measured and (2 g) introduced into a 250ml beaker. A neutral solvent (a mixture of petroleum ether and ethanol) was prepared and 50ml of it was taken and poured into the beaker containing the oil sample. The mixture was stirred vigorously for 30minutes. 0.56 g of potassium hydroxide (KOH) pellet was measured and placed in a separate beaker and 0.1M KOH was prepared, 3 drops of phenolphthalein indicator were added to the oil-ethanol-petroleum ether mixture and was titrated against 0.1M KOH till the colour turned pink and persisted for 15minutes. The acid value (AV) was determined using the equation (3).

$$AV = \frac{56.1XVXN}{W_{oil}} \quad 3$$

where; V= volume of standard alkali used; N= normality of standard alkali used;  $W_{oil}$  = weight of oil used

The percentage free fatty acid (%FFA) is gotten from equation 4

$$FFA = \frac{AV}{2} \quad 4$$

## 2.2 Determination of Rheological and Temperature Properties

The dynamic viscosity at 40°C and 100°C was determined according to the ASTM D2983 standard. A 2013 model NDJ-5S digital viscometer that measures in the range 10 to 2X10<sup>6</sup> mPas having an accuracy of ± 2% was used.

The viscosity index was determined according to ASTM D2270 standard using equation (5).

$$V.I = \frac{(L-U) \times 100}{(L-H)} \quad 5$$

where: V.I is the viscosity index, U is the kinematic viscosity of the oil to be determined measured at 40°C, L is the kinematic viscosity of the reference oil at 40°C, H is the kinematic viscosity of the reference oil at 100°C

The cloud point was measured according to the ASTM D2500. The pour point was determined according to the ASTM D97 standard. The flash point was measured according to the ASTM D92 standard. 30 mls of the oil was poured into an open cup apparatus and heated at atmospheric pressure while the temperature was being monitored with the digital infra-red thermometer. The set up was carried out in a fume chamber where air was being supplied to the heated oil until it ignited. The temperature at which it ignited was noted and recorded as the flash point of the oil.

### 2.3 Determination of Thermo-oxidative Stability

The peroxide value is essentially used as the basis for studying the stability of vegetable oils. The oxidative and thermal stabilities of the oils were determined by measuring peroxide values of the oils. The peroxide value was measured according to AOCS C/8 53 standard. 1g of oil was weighed into a clean drying boiling tube, 1g of powdered potassium iodide and 20ml of solvent mixture (2 volume of glacial acetic acid + 1 volume of chloroform) was added, the tube was placed in boiling water so that the liquid boils within 30 seconds and was also allowed to boil vigorously for not more than 30seconds. The content was quickly poured into a flask containing 20ml of potassium iodide solution; the tube was washed out with 25ml of distilled water and was titrated with 0.02M sodium thiosulphate solution using starch as indicator. A blank was also carried out at the same time. The peroxide value (PV) was determined from equation (6)

$$PV = \frac{(A-B) \times N \times 1000}{W_{oil}} \quad 6$$

where B = volume of sodium thiosulphate used in blank titration. A= volume of sodium thiosulphate used in titration with oil. N= normality of sodium thiosulphate (which is 0.02). W<sub>oil</sub>= weight of oil used.

### 2.4 Corrosion Level Test

The corrosion level of the oils was determined according to ASTM D4627. The experiment was conducted by measuring out 1g of cast iron chips onto a filter paper placed in a Petri dish. Then 2 mls of the particular oil collected with a pipette was used to wet the iron chips on the filter paper in the Petri dish and covered for 2 hours as shown in Plate 1. After which the iron chips were thrown away and the filter paper carefully rinsed out with tap water. The paper was treated with acetone and allowed to dry at room temperature, with the corrosion level assessed by sight.



**Plate 1:** Corrosion inhibition measurement

## 2.5. Biodegradability Test

The test for the biodegradability of the castor oil as compared to that of the SAE 20/W50 was carried out according to Ijah and Antai (2003). The extent of the degradation of the incorporated oils by *Bacillus sp.* CDB-08 bacterial isolated from petroleum contaminated soil was determined by gravimetric analysis method. The method involved the extraction of the residual oils with 50 ml petroleum ether and noting its absorbency reading at 520 nm wavelength. The percentage biodegradability of the oils was also determined by weighing the amount of recovered oil at interval of 7 days over a period of 28 days using equation 7.

$$\%Biodegradation = \frac{(W_{ao}-W_{ro})100}{W_{ao}} \quad 7$$

where  $W_{ao}$  = weight of the added oil; and  $W_{ro}$  = weight of the residual oil after days of bacterial inoculation.

## 3. Results and Discussion

### 3.1 Physicochemical Properties of Nigerian Castor Oil

The physicochemical properties of the castor oil and mineral oil-based lubricant (SAE 20W50) are as shown in Table I.

**Table I:** Physicochemical Properties of Castor Oil and SAE 20W50

S/No.	Property	Castor oil	SAE 20W50
1	Specific Gravity	0.955	0.878
2	Free Fatty Acid (mg KOH/g)	19.74	-
3	Saponification Value (mg KOH/g)	185.41	-
4	Acid value (mg KOH/g)	39.48	-
5	Iodine Value (gI <sub>2</sub> /100g oil)	92.1	80.0
6	pH	5.76	7.12
7	Density (kgm <sup>-3</sup> )	955	878

From the result, specific gravity and density of castor oil is 0.955 and 955 kg/m<sup>3</sup> respectively. These values for castor oil are slightly lower than the ASTM standard range (0.957 -0.961) The slight differences are as a result of differences in climate and soil conditions where the plants were grown and the condition of test. It can also be seen that the castor oil is denser than the mineral oil-based lubricant SAE 20W50 while both oils are less dense compared to water and would therefore float in water. The acid value of the castor oil is 39.48 mg KOH/g and its percentage free fatty acid 19.74 respectively. These values are too high and indicate that the oil is nonedible as the triglycerides in the oils have been decomposed. The lower the acid number the better the oil is as a lubricant as the high acid number oils are likely to corrode and wear machine parts that are lubricated. The results show that the castor oil will be a lower lubricant compared to the mineral oil SAE 20W50 with regards to the acid value. The oil will need modification to bring down its acid value for it to be a better industrial lubricant.

The saponification value of oil is a measure of the tendency of the oil to form soap during the transesterification reaction. The saponification value obtained for castor oil was 185.41 mgKOH/g which is slightly outside the range specified by American Oil Chemist Society (AOCS). These high saponification values shows that the oil will be more suited for soap and cosmetic making than for use as a lubricant, thus it may be necessary to modify the oil before use as lubricant. The iodine value shows the level of unsaturation of the oil and also influences the oxidation and deposition formed in internal combustion engines. It is used in determining the drying property of the oil. Iodine value obtained for castor oil was 92.1 gI<sub>2</sub>/100g while that of the mineral oil-based lubricant is 80.0 gI<sub>2</sub>/100g. The high iodine value of castor oil (92.1 gI<sub>2</sub>/100g) signifies that there is a high degree of unsaturation in the castor oil. Therefore, castor oil can be classified as unsaturated and non-drying oil since its iodine value is below 115 gI<sub>2</sub>/100g.

The pH value is a measure of the acidity or alkalinity of a fluid. The pH of the castor oil was 5.76, while the pH of SAE 20W50 mineral oil-based lubricant was 7.12. Thus, the castor oil is acidic whereas the mineral oil-based lubricant is slightly alkaline. It is more desirable for a lubricant to have a pH between 8.0 and 10.0; lubricant with very low or too high pH can be damaging to the skin of the end users. Besides microbial deterioration of biolubricants takes place in acidic medium rather than alkaline medium. The acidic pH of the

castor oil will reduce the corrosion protection of the machine components being lubricated thereby reducing their life span thus it is necessary to modify this oil to be suitable for use as lubricant.

### 3.2 Rheological and Temperature Properties

The rheological properties (viscosity and viscosity index) of the castor oil and mineral based lubricant (SAE 20W50) are shown in Table 2; while the temperature properties (cloud point, pour point and flash point) are shown in Table 3. Kinematic viscosity is one of the deciding parameters to evaluate the effectiveness of a lubricant. An increase in kinematic viscosity means increase in the lubricating property of the fluid (Rao et al., 2007).

From the results castor oil has kinematic viscosity of 280.6 cSt at 40°C which is higher than that of the mineral oil based lubricant SAE 20W50 (236.9 cSt). The very high viscosity of the castor oil is due to the presence of about 90% ricinoleic acid in the castor oil and is similar to the result gotten by other researchers (Silva et al., 2013; Zainal et al., 2018). Thus, at room temperature the castor oil possesses better lubricating properties than mineral oil based lubricant SAE 20W50. The kinematic viscosity of the castor oil is over three times that of the jatropha oil reported by Woma et al; (2019b). However, the castor oil viscosity at 100°C (77.5cSt) was lower than that of mineral oil-based lubricant at 100°C (99.1 cSt). This means that the castor oil has a lower viscosity index than the mineral oil based lubricant, therefore the castor oil will show more variation in viscosity at high temperatures compared to the mineral oil based lubricant. The castor oil conforms to the ISO VG 220 grade of industrial oil.

**Table 2:** Rheological Properties of castor oil and SAE 20W50

S/No.	Parameter	castor oil	SAE 20W50
1	Kinematic Viscosity at 40°C (cSt)	280.6	236.9
2	Kinematic Viscosity at 100°C (cSt)	77.5	99.1
3	Viscosity Index	33.4	65.0
4	Dynamic Viscosity at 40°C (mPas)	268.0	208.0
5	Dynamic Viscosity at 100°C (mPas)	74.0	87.0

Table 3 shows the pour point of the castor oil (-23.2°C) is very close to that of the SAE 20W50 (-24.1°C). Though the mineral oil has better cold flow properties than the castor oil, both the castor oil and SAE 20W50 oils have good cold flow properties (cloud point and pour point). The castor oil meets the cold flow properties standard for lubricants (-6°C for two-stroke engine lubricant as per IS14234 standard). Poor pour point has been what is lacking in most vegetable oils that hinder their applications in systems exposed to low temperatures. Thus, castor oil can be used for lubrication of machines exposed to low temperatures such as automotive engines, construction machines, military and space applications.

The flash point of the castor oil was (282°C) which was higher than that of the SAE 20W50 (255°C). Both oils have very high flash points which is desirable for a lubricant from the safety point of view. castor oil is safer than the mineral oil based lubricant SAE 20W50 to be used at high temperatures as lubricant. Castor oil has less fire hazard as a lubricant than most lubricating oils which has flash point of 210°C and fire point about 230°C (Stachowiak and Batchelor, 2000).

**Table 3:** Temperature Properties of castor oil and SAE 20W50

S/No.	Parameter	castor oil	SAE 20W50
1	Pour point (°C)	-23.2	-24.1
2	Cloud point (°C)	-12.4	-18.9
3	Flash point (°C)	282.0	255.0

### 3.3 Thermo-oxidative Stability of Nigerian Castor oil

The peroxide value is the usual method of assessment of primary oxidation products (Gunstone, 2004). Peroxide value of any oil gives an indication of its oxidative and thermal stability. The peroxide value of castor oil was 8.92 meq/kg, while that of the commercial mineral oil base lubricant (SAE 20W50) was 0.99 meq/kg. However, this peroxide value of the castor oil is too high showing that the oil has poor oxidative and thermal stabilities.

This result is consistent with the findings of all other researchers that had studied the thermo-oxidative stabilities of vegetable oils (Habibullah *et al.*, 2014; Musa *et al.*; 2015; Heikal *et al.* 2016; Aravind *et al.*; 2018 and Woma *et al.*; 2019b). The poor thermal and oxidation stability of the castor oil implies that lubricants formulated from this oil will have a low shelf life as degradation of the oil will take place very fast. The poor thermo-oxidative stability of castor oil is a major hindrance for its application as industrial lubricant; thus, the oil must be modified to be suitable for industrial lubricant application.

### 3.4 Corrosion inhibition level of Nigerian castor oil and SAE 20W50

The humidified cast iron chippings on filter paper covered in oil in a petri dish is shown in Figure 2 (a); while Figure 2 (b) is the castor oil filter paper after 2Hrs and Plate 2 (c) shows the SAE 20W50 filter paper after 2Hrs. No rust spot was found on both filter papers containing cast iron soaked in castor oil and SAE 20W50. Thus, both castor oil and SAE 20/W50 exhibits excellent corrosion inhibition characteristics and based on Alves and Oliveira (2008), both castor oil and the SAE 20W50 are of corrosion grade 0.

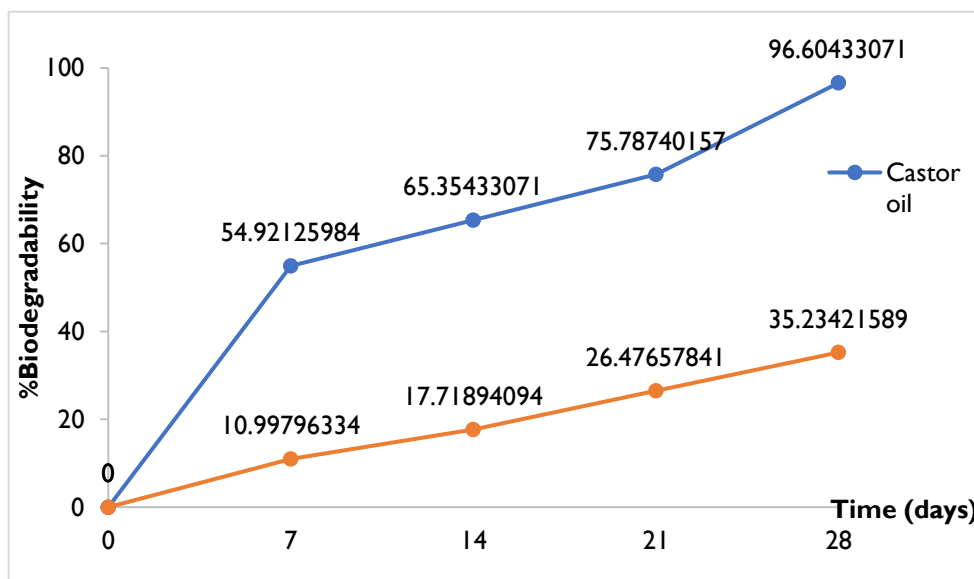


(a) Test with cast iron particles (b) after 2Hrs, castor oil (c) after 2Hrs, SAE 20W50

**Plate 2:** Corrosion inhibition tests of castor oil and SAE 20W50

### 3.5 Biodegradability of Nigerian castor oil and SAE 20W50

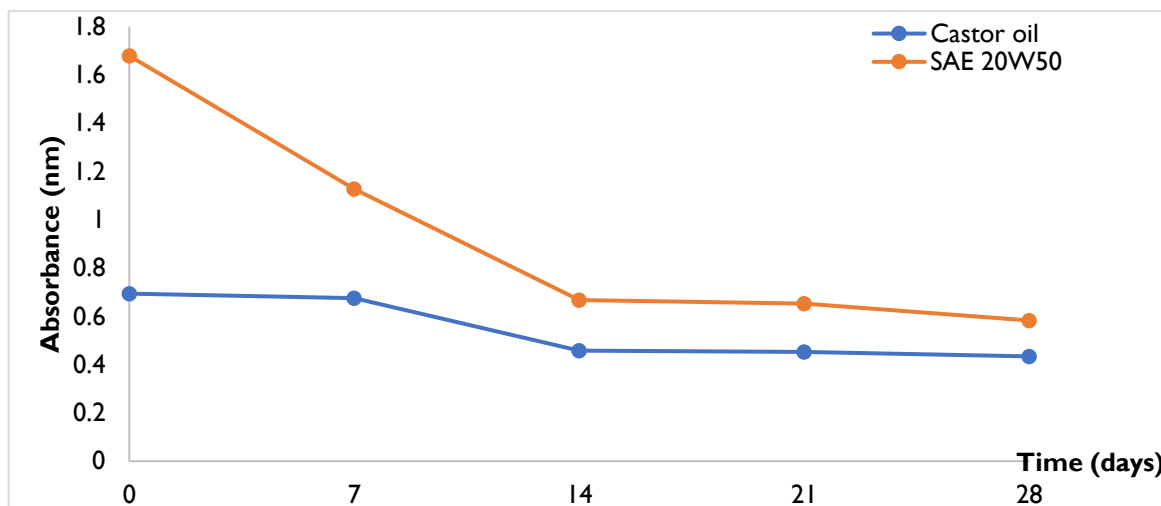
The percentage degradation of the castor oil and SAE20W50 over a period of 28 days after inoculation with bacterial is shown in Figure 1. The ultra-violet visible (UV-VIS) spectrophotometer absorbance at 520 nm wavelength of the castor oil and SAE 20W50 mineral oil over 28 days after inoculation with bacteria is shown in Figure 2.



**Figure 1:** Biodegradability of castor oil and SAE 20W50

The castor oil had 96.6 % biodegradability while the commercial mineral oil-based lubricant (SAE 20W50) had biodegradability of 35.2 % only. Thus, the Nigeria castor oil is classified as readily biodegradable since over 60 % of it was readily degraded by the bacteria in 28 days. The SAE 20W50 is not readily biodegradable since only 35.2 % (less than 60%) of the lubricant was degraded by the bacteria after 28 days. These findings are in agreement with the trends of tests carried out according to the Coordinating European Council (CEC) biodegradability test method, where mineral based lubricants have poor biodegradability between 15 - 35% and vegetable oils with excellent biodegradability between 70 – 100 % (Aluyor et al; 2009).

The castor oil had 54.9% biodegradability after 7 days of inoculation with the bacterial, this implies that the Nigerian castor oil is environmentally friendly as over 50% of it could be removed naturally from the environment within a week. Additionally, based on recent published benchmark criteria (Salih and Salimon, 2021; Khan et al; 2022), the Nigerian castor oil qualifies to be called a bio-lubricant.



**Figure 2:** UV-VIS Spectrophotometer absorbency readings of castor oil and SAE 20W50

The absorbency of UV rays by the castor oil after 28 days was 0.434 nm while that of the SAE 20W50 after 28 days was 0.583 nm. This indicates that the castor oil was more biodegradable than the SAE 20W50. Throughout the 28 days period of the test, castor oil absorbance of the UV rays was lower than that of the SAE 20W50. The castor oil was eaten up by the bacteria and the solution became less turbid thereby it absorbed less UV rays, whereas the bacteria were not able to consume the mineral oil-based lubricant SAE 20W50 therefore its solution remained turbid and absorbed more UV rays.

#### 4. Conclusion

The study of the physicochemical, rheological, temperature, thermo-oxidative stability, corrosion inhibition and biodegradability properties of castor oil extracted from Nigerian grown castor bean seeds have been carried out. Standard laboratory tests were carried out on the castor oil and commercially available mineral oil base lubricant (SAE 20W50) to determine their lubricant properties. The castor oil is acidic, unsaturated and has high saponification and free fatty acid values. There is need to modify the castor oil so as to improve its suitability as a base stock for the production of industrial lubricants. The castor oil has higher viscosity, but lower viscosity index compared to the mineral oil-based lubricant SAE 20W50. The castor oil conforms to the ISO VG220 grade of industrial lubricant oil and has excellent cold flow and fire hazard properties that do not require improvement. Furthermore, it has poor thermal and oxidative stability compared to the SAE 20W50. The castor oil extracted for Nigerian grown castor bean seeds has excellent corrosion inhibition properties. Both the castor oil and SAE 20W50 are of corrosion grade 0. The castor oil is highly biodegradable with over 90% biodegradability in 28 days while the mineral oil-based lubricant SAE 20W50 has poor biodegradability. By the criterion for classification of lubricants, the castor oil qualifies to be called a biolubricant



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