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COMPARATIVE EVALUATION of PHYSICOCHEMICAL PROPERTIES of Sudanese JATROPHA CURCAS SEED OIL with BIODIESEL

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ABSTRACT

Jatropha curcas is considered as an alternative energy source to help solve the energy crisis and environmental issues.A study on the physicochemical properties of Sudanese Jatropha curcas seed oil to evaluate as a source to produce biodiesel. The oil was obtained by chemical extraction and by mechanical pressing. The oil content in seeds was found to be about 30% (w/v). Physicochemical properties of Sudanese J. curcas seed oil: 1- (chemical extract) are: Density (0.91744, at 15 0C) biodiesel, 0.88 g/cm3 , specific gravity (0.91834), kinematic viscosity (35.36 mm2/5 at 40 0C) biodiesel 1.9 – 6.0 mm2/5, ; water content (0.0) biodiesel Max 0.05% ; flash point, 1850C) biodiesel Min 130 OC. ; cloud point, (0oC); pour point (-6oC); micro carbon residue (0.15%). 2- (pressing extract) are: (26.6%) (13.3%) acid number and & free fatty acid (0.91784 g/cm3) density at 15oC, (0.91874) specific gravity, and showed high value (35.73 mm2/5) kinematic viscosity at 40, (0.1%) water content, (208 oC) flash point, (3o C) cloud point, (-3o C) pour point, (0.2 %) micro carbon residue. The present study shows similar results color stability 1.5 and copper corrosion 1a for both chemical and pressing extract oil. The physicochemical properties of Sudanese jatropha cursas seed oil within the range of standards of biodiesel, but kinematic viscosity and free fatty acids are very high, so can be modified to decrease them.

1. INTRODUCTION

Jatropha Curcas is the Latin name which is always known as “Jatropha”. The genus contains fourteen species and it belongs to the family Euphorbiaceous-Spurge. Jatropha Curcas is a plant which yields seeds with higher oil contents. It can be grown under severe climate conditions such as tropical climate and land with little soil fertility. Jatropha has a toxic seed which make it as a non-edible crop. Jatropha seeds are produced oil from 30 to 40%. Therefore, it is likely to be a noble source of energy to produce biodiesel. Moreover, the seeds cake can be exploited as an organic fertilizer because it is rich of protein, nitrogen and pesticide and the plant remains useful for 35-50 years. Jatropha curcas has been recognized as new energy crop in many countries trying to grow their own renewable energy source with many promising benefits.

Jatropha in Sudan is located in several areas including Khartoum State, Central Sudan, Eastern Sudan (Kasala) and Western Sudan (Kordufan). The recent experimental and pilot project at Khartoum State , is belong to the Petroleum Laboratories, Research and Studies (PLRS) , its seeds was used in this study. The experimental and pilot project known as Kutum was launched in North Darfur with participation of a German research center, was all but success. The pilot project has proved that although Jatropha is an equatorial plan, it still can grow in all types of soils found in the Sudan[4] .

Studies shows that the mature plant usually produces capsule shape fruits in winter or during the year if the soil moisture is good and temperature is appropriately.

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The seeds are black and range from 10 mm long and 10 mm wide and become matured when the seeds color changes from green to yellow. This usually takes 3 to 4 months after the flowering and there are 1375 seeds/kg in average.

The Jatropha leaves contain different chemical compounds such as saccharose, raffinose, stachyose, glucose, fructose, galactose, and protein. Fatty acids such as oleic, linoleic, palmatic acids. Others acids are also been reported[3]

Vegetable oils, also known as triglycerides, are becoming one of the promising renewable feedstocks for biodiesel production and have become more attractive recently because of its environmental benefits[2]

The use of vegetable oils as alternative fuels has been around since 1900 when the inventor of the diesel engine Rudolph Diesel first tested peanut oil in his compression ignition engine[1].

Biofuels are considered in part, a solution to such issues as sustainable development, energy security and a reduction of greenhouse gas emissions. Biodiesel, an environmental friendly diesel fuel similar to petro-diesel in combustion properties, has received considerable attention in the recent past worldwide. Biodiesel is a methyl or ethyl ester of fatty acids made from renewable biological resources such as vegetable oils , recycled waste vegetable oil[1]

2. MATERIALS AND METHODS

2.1 Seed Material

Sudanese Jatropha curcas seeds used in this study was kindly supplied by Petroleum Laboratories, Research and Studies (PLRS).
Seeds were in a good condition, cleaned, and shells were removed manually before using.
N-Hexane used as a solvent was kindly supplied by Africa City of Technology.

2.2 Oil extraction

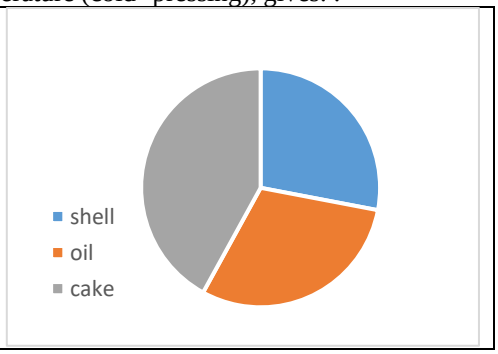
2.2.1 Chemical extraction

The extraction of jatropha oil was carried out using solvent extraction.
The oil was extracted from the jatropha crushed seeds using n-hexane as a solvent by soxhlet apparatus for 8 hrs.
The extracted oil was filtered and excess solvent was removed using a rotary evaporator at 40°C.
The chemical extraction and chemical tests were performed in Africa City.

2.2.2 Mechanical pressing

2.2.3 seeds were pressed using a local machine under normal temperature (cold- pressing), gives: .

	Cold pressing extract	Solvent extract
Shell	28%	28%
Oil	28%	30%
Cake	44%	42%



Sudanese Jatropha seed

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2.3 Tests

Jatropha Oil obtained from the experiment was performed the ASTM characterization in accordance with ASTM D6751 standard. The ASTM testing procedures including acid number (ASTM D974), density,SPG, API (D4052 & D1298), kinematic viscosity (ASTM D445), color stability (ASTM D1500), water content (D95), copper corrosion (ASTM D130), flash point (ASTM D93), cloud and pour point (ASTM D97), micro carbon residue (ASTM D4737).

2.3.1 Chemical tests

Acid number & Free Fatty Acids (FFA):

The acid number and free acids contents were determined according to ASTM D974 using color-indicator titration.

Added 100 ml of the isopropyl alcohol to 250 ml Erlenmeyer flask. Then added approximately 10 drops of phenolphthalein indicator solution.

Pour weighed sample of approximately 20g into the solvent.
Titrated while stirring with potassium hydroxide titrant (in burette) to the end point, which is a definite color change to green-brown color that persisted for more than 15 sec. then recorded the KOH volume that consumed.

To calculate the acid number:

$$\text{Acid value} = \frac{\text{Volume of KOH (ml) X Normality of KOH (N) X 56.1}}{\text{Mass of sample (g)}}$$

To express this value as a percent of free fatty acids (FFA):

$$\text{FFA} = \frac{\text{Acid value}}{2}$$

2.3.2 Physical tests

The sample physical analysis was held in PLRS.

Density at 15ºc, Specific gravity, API:

These tests of oil was determined using DMA 4500M Anton Paar density meter - Germany.
Method: ASTM D4052 & D1298

Kinematic Viscosity:

The kinematic viscosity was determined using LAUDA E 200 Viscometer - UK at 40ºc.
Method: ASTM D445

Color stability:

Colorimetric measurement, was carried out using a manual colorimeter
SETA- Lovi Bond PDCAF 650 – England.
Method: ASTM D1500

Water content:

The water content was determined by water by distillation method, using Dean Stark Extraction System (round bottom + trap + condenser).
Method: ASTM D95.

Copper Corrosion:

The copper strip corrosion was determined using copper strip corrosion path, Linetronic Technologies – Switzerland.
3 hrs. under 100ºc.

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Method: ASTM D130

Flash point:
The flash point was determined using Multiflash automatic, SETA- Pensky Martin, – England.
Method: ASTM D93

Cloud and Pour point:
The cloud and pour point were determined using cloud and pour test cabinet, Normalab analysis – France.
Method: ASTM D97

Micro Carbon Residue:
The MCR was determined using microcarbon residue App, Normalab analysis.
Method: ASTM D4737

3. RESULTS

Property	**Chemical Extract**	**Pressing Extract**	**Biodiesel standard** ASTM 6751
Density (at 15 ^{0}C)	0.91744 g/cm^3	0.91784 g/cm^3	0.88 g/cm^3
Specific gravity	0.91834	0.91874	-
API	22.58	22.51	-
Kinematic viscosity at 40 ^{O}C	35.36 mm$^{2/5}$	35.73 mm$^{2/5}$	1.9 – 6.0 mm$^{2/5}$
Color scale	1.5	1.5	Max 3
water content	0.00%	0.01%	Max 0.05%
Copper corrosion	1a	1a	Max no. 1
flash point	185 ^{O}C	208 ^{O}C	Min 130 ^{O}C
cloud point	0 ^{O}C	3 ^{O}C	Max 12 ^{O}C
pour point	-6 ^{O}C	-3^o C	-
micro carbon residue	0.15%	0.20 %	Max 0.5%
Acid Number (mg/kOH/g)	-	26.6 mg/kOH/g	Max 0.8 mg/kohls/g

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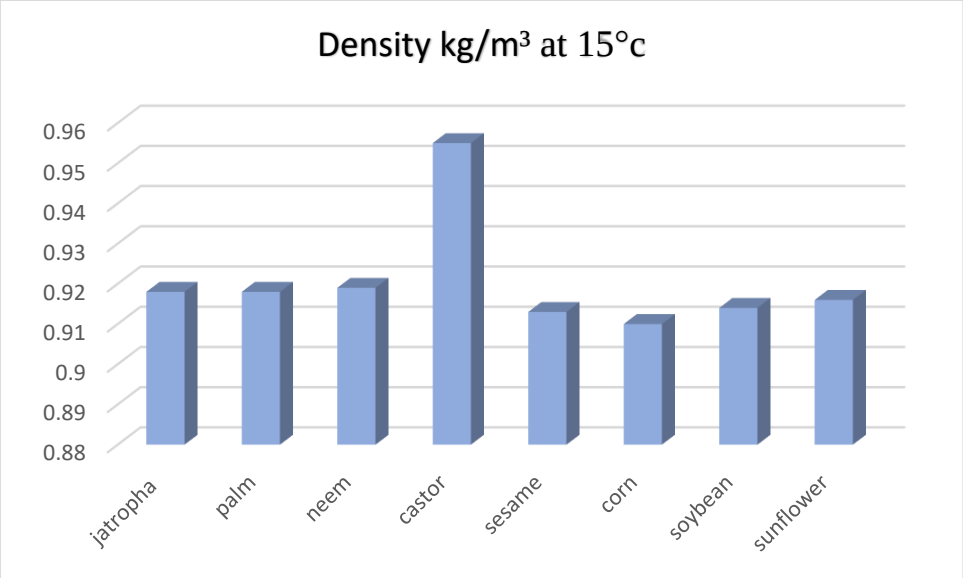
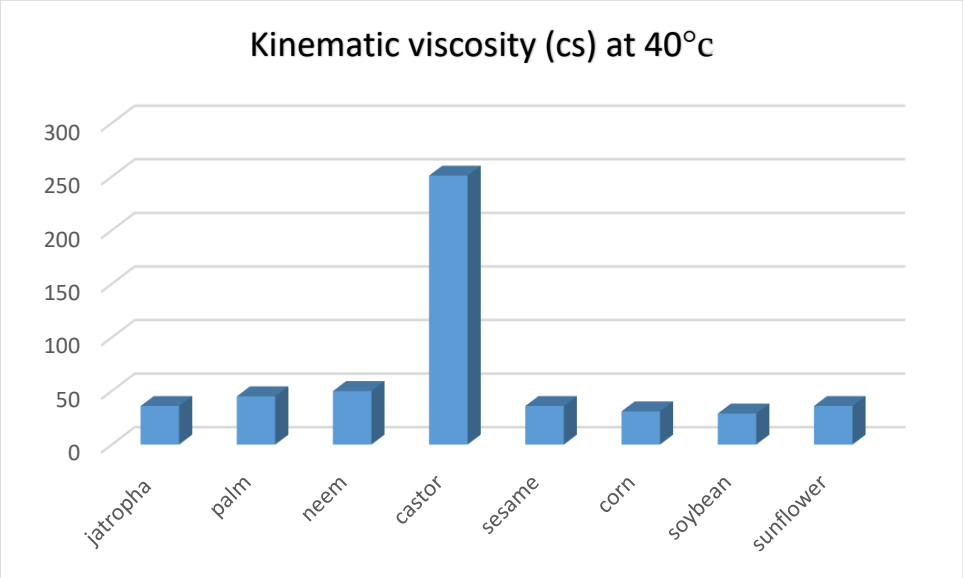
Free fatty acid	-	13.3%	-

Comparison between some characteristics of Sudanese jatropha oil in this study and other vegetable oils from literature[5] :
(Using oils extracted by mechanical pressing)





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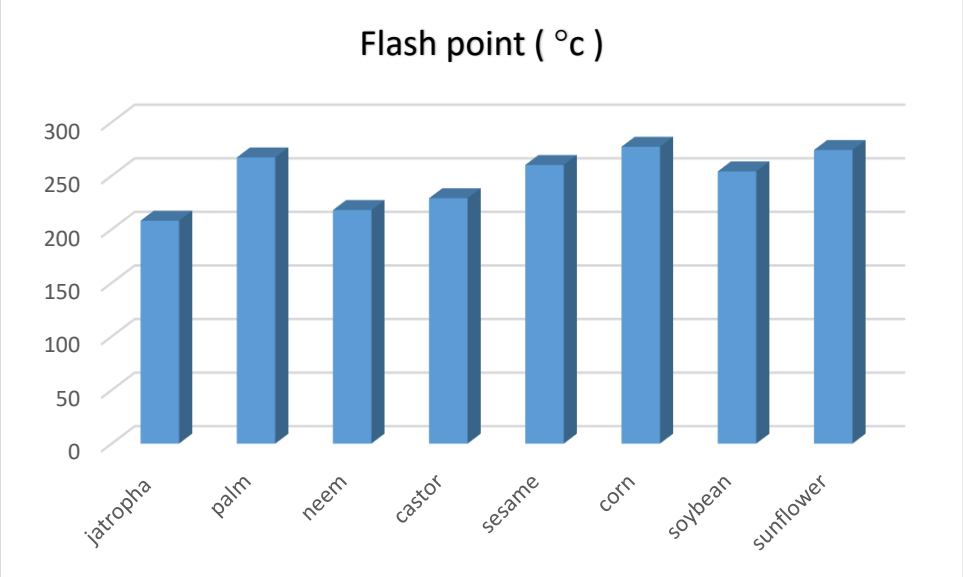

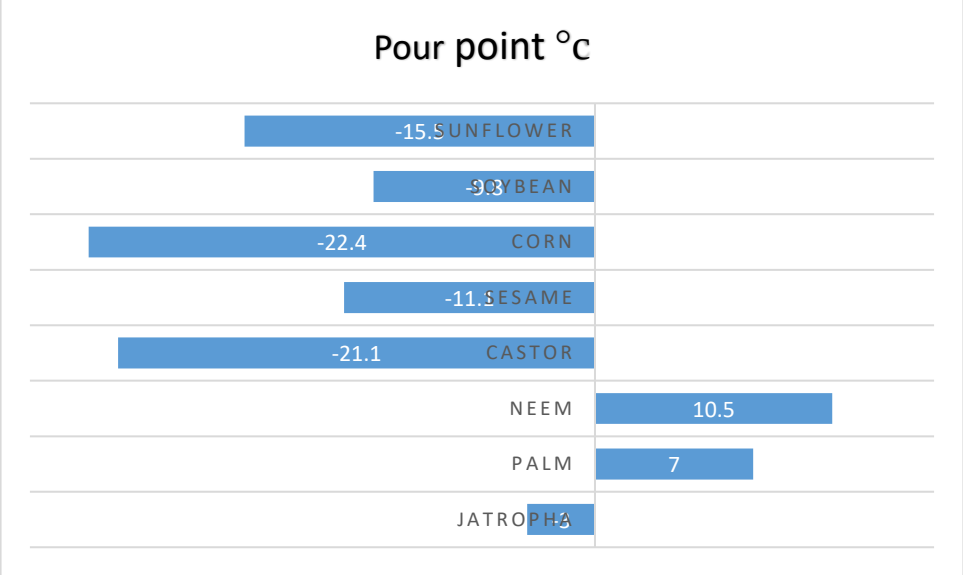

4. DISCUSSION AND CONCLUSION

For comparative evaluation of physicochemical properties of Sudanese jatropha curcas seed oil with standard biodiesel, is discussed that , the color scale, water content, flash point, copper corrosion, pour point and MCR of Sudanese Jatropha Oil, observed to be similar to those of the biodiesel fuel standard..

The acid number and FFA showed higher value compared to the biodiesel standard, high acidity can cause damage to engine feed circuit, it can be reduced by its pretreatment with methanol using sulfuric acid as catalyst.

Values of density and kinematic viscosity of the Sudanese Jatropha Oil are higher than biodiesel standard values, higher values of these properties can cause problems in injection nozzle and combustion chamber. High density and viscosity can be modified by trans-esterification converting triglycerides (Oil) to esters.
Direct usage of jatropha is possible if it is heated up between 90 °C and 100 °C, because that decrease density and viscosity to the standard range of biodiesel[6] .

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Sudanese Jatropha Oil, is a promising source of biodiesel since its seeds contain high amount of the oil and the species has good agronomic traits.

The plant is widely seen to have potential to help combat the greenhouse effect, create additional income for the rural poor, and provide a major source of renewable energy both locally and internationally.

The oil from its seeds is the most valuable product since it can be converted into biodiesel.

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