Characterisation of a biodiesel from an alkali transesterification of jatropha curcas oil

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Introduction

Guinea imports the totality of oil and deriveted products to cover its increasing eergy needs. In contrast to other underground resources as iron , aluminium, gold , the geological surveys have still established the existence of crude oil or natural gas on the territory. The increasing consumption of fossil fuel and petroleum products are a matter of concern for the country as it is related to huge outgo of foreign exchange in the context of severe economic crisis and depression. The energy trend offers a challenge as well as an opportunity to look for substitutes of fossil fuels for both economic and environmental benefits. Investigation and development of bio-fuels as an alternative and renewable source of energy for transportation has become a major target in the effort towards energy self-reliance. Bio-fuel commands crucial advantages such as technical feasibility of blending, superiority from the environment and emission reduction angle, its capacity to provide energy security to remote and rural areas and employment generation. Moreover, Bio fuel will also provide rich bio mass and nutrients to the soil and check degradation of land. In Guinea the use of crude jatropha oil is known since centuries. After Carrière **(1)** a report exists since 1906 on the use of the oil as biofuel for household in the country.

The reknown german website " *Bagani* " on jatropha oil technology is a manden (bambara, maninka, dioula, sénoufo, soussou, etc.) word. It comes from " *baga* " or " *baa* " meaning poison and any toxic product. The suffix " ni " is a dimunitive meaning small. This appelation of the plant is due to the fact that it is not browse by cattle. *Jatropha curcas* is a quick maturing plant species that starts bearing fruits within a year of its planting and following the extraction and trans-esterification the oil can be blended with petroleum diesel for use. It grows in a wide variety of agro-climatic conditions of Guinea .

A key problem associated with the use of pure vegetable oils as fuels for diesel engines is caused by high fuel viscosity in compression ignition. Amongst the techniques applied to overcome the difficulties encountered with the high fuel viscosity, chemical conversion of the oil to its corresponding fatty ester is the most promising solution. Transesterification means taking a triglyceride molecule or a complex fatty acid, neutralizing the free fatty acids, removing the glycerin and creating an alcohol ester. In this work we mixed ethanol with sodium hydroxide to make sodium ethoxide. This liquid is then mixed into vegetable oil. The poperties of the resulting biodiesel are compared to ASTM and EN diesel and biodiesel standards.

Material and methods

Jatropha curcas seeds were purchased on free market in Dinguiraye in Guinea, they were manualy seperated from the shell. *Jatropha* seeds were cracked, the shells carefully removed and the kernels thus obtained were used for oil preparation. Two kilogrammes of seed resulted with 0,9916 g clean kernel. The average seed weight varied from 0.50 to 0.71 g and kernel weight was 57-63 % of raw seed weight. The oil was prepared by grinding *Jatropha* seed kernels.

The crude oil was extracted mecanichally with a chinease press ZX-10; capacity 200 kg/h. The oil is collected in a plastic cain and stand 24h , then the oil was carefully decanted.

A sample 100g of the crude oil was taken for analysis.

For the transesterification we choosed ethanol as alcohol and NaOH pellets as alcali-agent.

The Biodiesel production Formula **(2)** can be presented as follows**:**

100 pounds of oil + 20 pounds of methanol =

=100 pounds of biodiesel + 10 pounds of glycerol + 10 pounds of methanol

The molecular weight of the jatropha oil being 870, stechimetically the formula means that 3 moles of alcohol are required to esterify one mole of oil. In the literaure the upper limit of required natrium hydroxid amounts 1,2% of the alcohol quantity **(3)**.

The experimental work was carried out i a classic three-necked flask system as follows. The stechiometrically defined weights of reacting products are: 300g (0,34 mole) of crude jatropha curcas oil; 47,55 g (0,34 mole) ethyl alcohol and 3g (0,075mole) NaOH corresponding to 1% of the alcohol weight. The weighing were done with a machine Satorus BP 4100.

After weighing the oil was taken in a 500 ml three-necked round flask. A water condenser system and a thermometer were connected to the flask. The oil was warmed by placing the flask in a 60°C (a much lower temperature than the boiling point) water bath. Then the NaOH pellets was dissolved ethanol. The mixture is stirred in order to obtain the corresponding sodium ethoxide.

The sodium ethoxide solution was gradually added into the jatropha crude oil ; the mixture were sirreed during two hours in the warm water bath. The resulting product was taken into a separating funnel and stand 24 hours. Two phases were distinct: a golden yellow liquid representing the biodiesel on top and the glycerol at the bottom. They were separated and the biodiesel was collected in a flask and then washed with distillated water in order to reduce its pH value.

The colored was assessed with a simple organoleptic obervation . While standard methods were used to determine the physico-chemical properties of both crude oil and the resulting biodiesel.

Endly the seed residue obtained after oil extraction was analysed with regard to N, P, and K as plant nutrients. The Nessler method was used to determine N; total P_2O_5 and K_2O were determined by Phosver 3 and tetraphenyl borate methods respectively.

Results and discussion

The investigated properties: color, specific gravity, free fatty acids and acid value are presented on Tab.1.The kinematic viscosity of the crude oil decreased about 82% after transesterification and amounts 4,8 mm^2/s. It represents the half of the EN standard and is in the limits of the ASTM ()biodiesel norms 1,9-6,0 mm^2/s . Through this reduction that flow ability of the crude oil increased in agreat extend. As stated earlier the high viscosity of plant oil represents one of main constraints to their use as fuel for engins. The following schema (4)Org. Experim. Chemie) shows the viscosity grade for different fatty substances. decreasing viscosity from solid mutton suet to liquid olive oil and increasing one from liquid rape oil to solid cow suet.

	Mutton suet	Butter	olive oil	
Solid	←	———	→	Liquid
	Cow suet	Pigs fatt	Rape oil	

The specific gravity of the investigated samples is slightly inferior to the EN classic diesel quality but very closed to the that of its biodiesel.

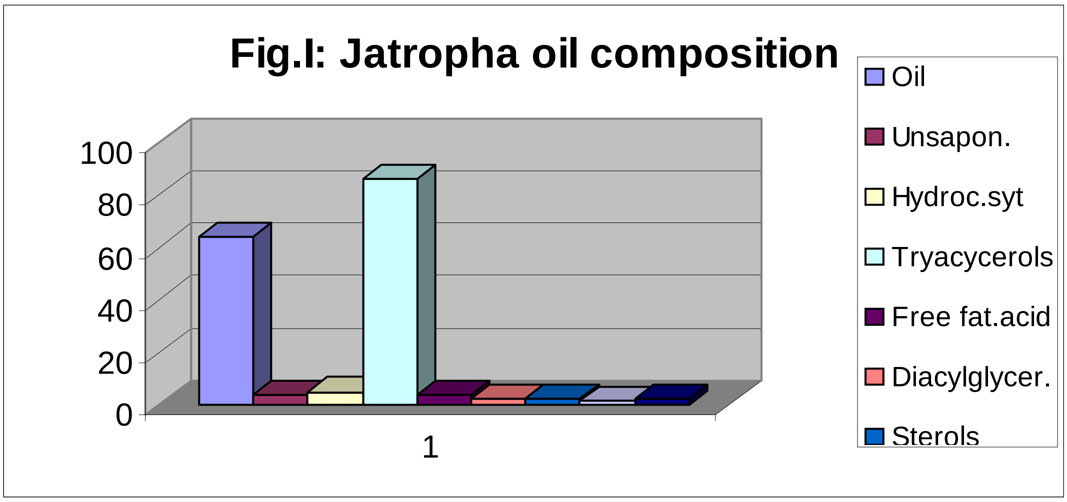
The transesterification of the Jatropha curcas crude oil resulted with an acid value less than 8% from 6,3 to 0,49. Acid numbers higher than 0.80 have been found to cause fuel system deposits and reduced life for fuel pumps and filters.

Table I: Comparison of the physico chemical prameters of the investigated sample to ASTM and EN standarrds

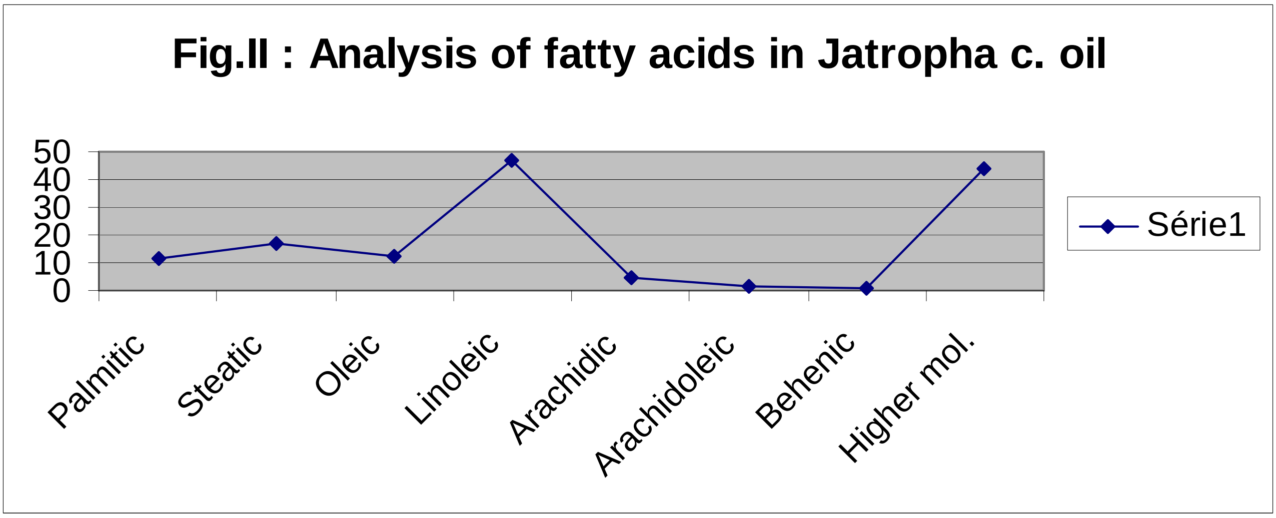
Parameter	ASTM diese.	ASTM biodie.	EN-diesel	EN-biodsel	Crude oil	Transest.biod
Color	Gold. yellow	Gold. yellow	Gold. yell.	Gold. yell.	Gold. yell.	Gold. yell.
Kinematic viscosity mm^2/s	2,4-4,1	1,9-6,0	2,0-4,5	3,5-5	27,11	4,8
Specific gravity	-	-	0,82-0,845	0,86-0,90	0,92	0,87
Free fatty acid					3,1	0,25
Acid value (mgKOH/g sple)		0,80		0,50	6,3	0,49

With about 80%, triacylglycerol represents the main contituent of the jatropha curcas oil. The jatropha curcas seed is very rich with oil as shows fig.I. It is probably one of richest small oil seed. *Jatropha* oil is reportedly present in the range of 40-60 g oil/100 g *Jatropha* seed kernels **(5)**. Several other lipid substances were found. They range from 5% for hydrocarbons to 1,5% for monoacylglycerols.

After presence of unsaponifiable substances explains the pesticide character of jatropha curcas oil.



The analysis of the fatty acids of the oil shows that lineolic acid is the main one . It is followed by the C24 molecules with more than 40%. Stearic acid represeznts an important part of the fatty acids as presented on fig.II



After oil extraction the seed residue known as "cake" was analysed with regard to plant major nutrient: N, P, K. The results show that the cake is relatively rich with nitrogen with 5,76%. Phosphorus and potassium represent 3 and about 1% respectively.

Conclusion

The biodiesel is a suitable substitute to fossil fuel whose reserve has been exhausted Besides, since biodiesel is also an environmental friendly fuel because of its properties such as "*clean burning*" and "*non-toxic*" fuel, the biodiesel technology and market is highly prospective.

The under exploited and vegetable oils are good sources of biofuel especially for countries which do not have natural oil deposits. Guinea is endowed with many plants species rich with oil with intersting biodiesel properties. For instance *Bagani* or *Jatropha curcas* oil is used in the country since centuries. With a concentrated and coordinated effort, research works should be carried out to convert vegetable oils into biodiesel through simple biotechnological processes.

The investigated crude and transestrified *Bagani* oil samples showed properties and composition that are conform to the ASTM and EN standards.

References

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