Global Journal of Science Frontier Research
Chemistry
Volume 12 Issue 7 Version 1.0 Year 2012
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Comparative Studies on the Functional Properties of Neem, Jatropha, Castor, and Moringa Seeds Oil as Potential Feed Stocks for Biodiesel Production in Nigeria

By S.G. Zaku, S. A. Emmanual, A.H. Isa & A. Kabir
Energy Commission of Nigeria

Abstract - Fossil fuel resources are decreasing daily while biodiesel fuels are attracting increasing attention worldwide as blending components or direct replacements for diesel fuel in vehicle engines. This study investigated the physicochemical properties of oils extracted from Jatropha, neem, moringa and castor seeds for their suitability in biodiesel production. This is with a view to compare which of the oils has better functional properties for a quality biodiesel production. Our results has shown that all the oil from the plants seed study, have good physiochemical properties and are very good precursor for biodiesel synthesis.

Keywords : biodiesel, feedstock, biofuel, renewable.

GJSFR-B Classification : FOR Code: 090405

COMPARATIVE STUDIES ON THE FUNCTIONAL PROPERTIES OF NEEM, JATROPHA, CASTOR, AND MORINGA SEEDS OIL AS POTENTIAL FEED STOCKS FOR BIODIESEL PRODUCTION IN NIGERIA

Strictly as per the compliance and regulations of :

Comparative Studies on the Functional Properties of Neem, Jatropha, Castor, and Moringa Seeds Oil as Potential Feed Stocks for Biodiesel Production in Nigeria

S.G. Zaku [α], S. A. Emmanual [σ], A.H. Isa [ρ] & A. Kabir [ω]

Abstract - Fossil fuel resources are decreasing daily while biodiesel fuels are attracting increasing attention worldwide as blending components or direct replacements for diesel fuel in vehicle engines. This study investigated the physicochemical properties of oils extracted from Jatropha, neem, moringa and castor seeds for their suitability in biodiesel production. This is with a view to compare which of the oils has better functional properties for a quality biodiesel production. Our results has shown that all the oil from the plants seed study, have good physiochemical properties and are very good precursor for biodiesel synthesis.

Keywords : biodiesel, feedstock, biofuel, renewable.

I. Introduction

The major percentages of energy used in the world today are being generated from fossil fuel sources. These fossil fuels are non-renewable resources that take millions of years to form and their reserves are being depleted faster than they are being regenerated. They are the major contributors and sources of green house gases, air pollution and global warming. Some of the emissions generated from these fossil fuels are CO, CO_2, NO_X, SO_X, unburnt or partially burnt hydrocarbon and particulate(Ndana et al.,2011). This rate of depletion and environmental issue is seriously calling for an alternative.

Biodiesel, a form of Biofuel is an answer to this call. It is a fuel derived from renewable biological sources that can be added to petroleum diesel as a blend or used on its own in diesel engines. The first diesel engines by Rudolph Diesel in the 1890s were designed to run on refined vegetable oils. Biodiesel fuel is now attracting increasing attention worldwide as a blending component or a direct replacement for diesel fuel in vehicle engines (Demirba, 2009). Biodiesel blends of up to B_{20} can be used in nearly all diesel equipment and are compatible with most storage and distribution equipment. These low-level blends generally do not require any engine modifications. Based on these criteria, Jatropha curcas , neem, moringa oleifera and castor oils have been found to be useful renewable sources for biodiesel production.

Jatropha curcas is drought-resistant oil bearing multi-purpose shrub/small tree, belonging to the family of *Euphor-biaceae* (Wang et al., 2011). It originates from Central America and is widely grown in Mexico, China, and north-east Thailand, India, Nepal, Brazil, Ghana, Mali, Zimbabwe, Nigeria, Ma-lawi, Zambia and some other countries (Baroi et al., 2009). The plants grow quickly forming a thick bushy fence in a short period of time of 6 – 9 months, and growing to heights of 4m with thick branches in 2–3 years. It grows in arid and semi arid climates and in a wide range of rainfall regimes, from 200 to 1500 mm per annum [5]. It can survive in poor stony soils, and has a life span of 50 years (Baroi et al., 2009). *Jatropha curcas* can produce significant amounts of oil in their respective seeds. The oil content of the seeds varies from 30 to 60% depending on the variety, place and the method of oil extraction (Baroi et al., 2009).

Neem (*Azadirochta indica A. Juss*) is a native Indian tree well known for its medicinal features. Most of the parts such as leaves, bark, flower, fruit, seed and root have applications in the field of medicine (Muthu et al., 2010). It is an evergreen tree related to mahogany, growing in almost every state of India, South East Asian countries and West Africa (Muthu et al., 2010). It grows in drier areas and in all kinds of soil. It contains several thousands of chemicals which are terpenoids in nature. A mature neem tree produces 30 to 50 kg fruit every year and has a productive life span of 150 to 200 years (Ragit et al., 2011). It has the ability to survive on drought and poor soils at a very hot temperature of 44°C and a low temperature of up to 4°C, and its high oil content of 39.7 to 60% (Ragit et al., 2011).

Moringa *oleifera* Lam belongs to an onogeneric family of shrubs and tree, Moringaceae and is considered to have its origin in Agra and Oudh, in the northwest region of India, south of the Himalayan Mountains. There is evidence that the cultivation of this tree in India dates back many thousands of years. The Indians knew that the seeds contain edible oil and they

Author α ρ ω : Energy Commission of Nigeria, Plot 701c Central Area, P.M.B 358 Garki, FCT- Abuja.
Author σ : Chemistry Advance Laboratory, Sheda Science and Technology Complex, P.M.B.186, Garki, Abuja FCT, Nigeria.

used them for medicinal purposes. It is probable that the common people also knew of its value as a fodder or vegetable. This tree can be found growing naturally at elevations of up to 1,000 m above sea level. It can grow well on hillsides but is more frequently found growing on pastureland or in river basins. It is a fast growing tree and has been found to grow to 6 – 7m in one year in areas receiving less than 400 mm mean annual rainfall (Odee, 1998). In English it is commonly known as Horseradish tree, Drumstick tree, Never Die tree, West Indian Ben tree, and Radish tree (Ramachandran *et al.*, 1980). The seed contain between 30 - 50% oil.

Castor oil plant (Ricinus communis L.) Is a species of flowering plant in the spurge family, Euphorbiaceae. It belongs to a monotypic genus, Ricinus, and subtribe, Ricininae. It seed is the castor bean; it is indigenous to the Southeastern Mediterranean basin, Eastern Africa, and India, but widespread throughout tropical regions (Muthu et al., 2010). Castor seed is the source of castor oil, which has a wide variety of uses. The seed contain between 40 - 60% oil that is rich in triglycerides, mainly ricinolein. The seed contain ricin, a toxin, which is also present in lower concentrations throughout the plant.

To date, reports on the use of these oils, in particular neem, castor and moringa oil in Nigeria, for the production of biodiesel are not available while that of Jatropha curcas is limited (Belewu et al., 2010). The fatty acid compositions of the oils (Table I) and their physicochemical properties (Table II) have been investigated. The results of this study would form a basis for the development of a database for biodiesel production from these feedstocks, especially in countries where they are in abundance. Hence, this paper evaluates the physiochemical properties of oils extracted from the selected plants seeds.

II. Materials and Methods

Seeds sample Source;

The studied plant seeds were collected from different places within the Northern part of Nigeria. Neem seeds (Azadirachta indica) and Castor seed (Ricinus communis) were collected dry from Yelwa, Plateau state. Moringa seed (Moringa oleifera) from Sheda Science and Technology Complex, Abuja while Jatropha (Jatropha curcas) seeds were obtained from National Research Institute for Chemical Technology Zaria.

Sample preparation and oil extraction

The seeds collected were cleaned by removing foreign materials such as ticks, stains, leaves, other seeds, sand and dirt. After cleaning, the seeds were dried in the oven at 500C for 72 hours until constant masses were obtained. The dried seeds were then mechanically dehauled to remove the seed coat. Removal of the seed coat is imperative because the seed coat contains little or no oil and more importantly inclusion would make extraction less efficient. The dehauled seeds were further dried at 500C for another 48hours and ground to powder using mortar and pestle. The oil was extracted separately from each type of seeds using Soxhlet extractor with n-hexane as a solvent. The percentage oil yield and free fatty acid level were determined. The physicochemical analysis of oils was carried out according to AOAC (1990), AOCS (1997) and Standard methods were used for the determination of oils properties.

III. Results

Table I : percentage oil yield and free fatty acid level of the samples.

Samples	Percentage yield (%)	Acid value (mg KOH/g)	FFA (mg KOH/g)
Jatropha seed oil	46.4	8.43	4.22
Castor seed oil	47.2	12.48	6.24
Neem seed oil	45.3	17.40	8.70
Moringa seed oil	40.2	4.96	2.48

Note : Free fatty acids (FFA) value is half of the acid value

Table II : Physicochemical properties of oils obtained from four different plants seed.

Parameters	Jatropha Seed oil	Castor seed oil	Neem seed oil	Moringa seed oil
Moisture Content (%)	2.39	3.48	2.53	0.043
Ash content (%)	12.5	15	11.10	7.5

Saponification Value (mgKOH/g)	191.8	164.1	186.4	188.1
Iodine value (meq/g)	62.12	45.26	58.20	66.2
Peroxide value (meq/g)	40	10	78.40	3.50
S. G. at 15/4^{0}C	0.9156	0.9178	0.9327	0.9080
Viscosity (Mpa)	88.15	81.95	88.40	49.96

IV. Discussion

The oil yields of all the seeds (Jatropha curcas 46.4%, Neem 45.3%, Castor 47.2% and Moringa seed 40.2%) are shown in Table I. These results fall within the range of the percentage oil content (30 - 60%) reported by Azam et al., (2005), and (Sneha et.al (2009). The results indicate that all the sample seed contains appreciable quantity of oil enough to be extracted for commercial scale production of biodiesel. The obtained values for the free fatty acid level of the oils are presented on Table I. The acid value is a measure of the amount of carboxylic acid groups present per gramme of the oil and the higher value significantly affect efficiency of transesterification and consequently result in low yield, (Conackci et al., 2001). The result on Table 1 shows that all the oils contain high acid value except that of moringa seed; as such the oil cannot be directly transesterified. Transesterification can only be achieved when the acid value is 2% or 1% FFA. There is therefore the need to carry out acid esterification of the oil as to reduce high acid value to 2% or less prior to alkaline transesterification, and this could probably lead to optimal biodiesel yield. The quality of oils expressed in terms of the physicochemical properties such as moisture content, ash content, saponification value, iodine value, peroxide value, specific gravity and viscosity are shown in Table II. The moisture content of the samples shown in table 2 are Jatropha 2.39%, Castor seed 3.48% , Moringa seed 0.043 %and Neem seed 2.53%. These values are low especially that of Moringa signifying that the seeds can dry well and can be stored for a long time. The ash contents are fairly low indicating that mineral contents are low. The values for specific gravity of oils samples shown in Table II were found to be within the range of 0.717- 0.921as reported by Danguguwa (1983) except neem seed oil that is insignificantly above the range. The saponification values were low when compared with the value of 190 - 194 reported by Eteshola (1990); this signifies that these oils are of good quality for use as feedstock for biodiesel production.

V. Conclusions

In this article, a comparative study on the functional properties of oils extracted from jatropha, neem,castor and moringa seeds for their suitability in biodiesel production, shown that all the oils can be used as raw materials to obtain biodiesel fuel of high quality and could be suitable alternative to fossil diesel.

References Références Referencias

1. Anonymous. 1990. Official Methods of Association of Official Analytical Chemists, 15th Ed. AOAC Inc., Suite 4000, Virginia, USA.
2. Anonymous. 1997. Official and Recommended Practices of the American Oil Chemists Society (5th Ed.). AOCS Press, Champaign.
3. Anonymous. 1987. Standard Methods for the Analysis of Oils, Fats and Derivatives International Union of Pure and Applied Chemistry (IUPAC), (7th revised and enlarged (ed.): Paquot, C., Hautfenne, A., Eds., Blackwell Scientific Publications, London.
4. Azam M. M, Waris A, Nahar N M (2005). Prospect and potential of fatty acid methyl esters of some nontraditional seed oil for use as biodiesel in India Biomass and Bioenergy 29: 293-302.
5. Baroi, C, Yanful, E. K, Bergougnou, M. A(2009). Biodiesel Production from Jatropha curcas Oil Using Potassium Carbonate as an Unsupported Catalyst. *Int.* J. Chem. Reactor Eng., 7 (7), 72.
6. Belewu, M, Adekola, F. A, Adebayo, G. B, Ameen, O. M., Muhammed, N. O, Olaniyan, A. M, Adekola, O. F, Musa, A. K (2010). Physico-chemical characteristics of oil and biodiesel from Nigerian and Indian Jatropha curcas seeds. *Int. J. Biol. Chem. Sci., 4* (2), 524-529.
7. Conakci M, Van Gerpen J, (2001). Biodiesel production from oils and fats with high free fatty acids Transaction of the SAE, 44 (6), 1429-1436.
8. Danguguwa AA (1983), "Cultivation of Tiger Nut in Bauchi, Samaru" Agricultural newsletter, 5, 86-87.
9. Demirba , A (2009). Production of biodiesel from algae oils. Energy Sources A Recover. Util. Environ. Effects, *31* (2), 163-168.
10. Eteshola E (1990). Fatty acid composition of Tiger Nut Tubers, Baobub seeds and their Mixtures. Journal of the Amarica Oil Chemists Society, 73, 225-257.
11. Muthu, H, SathyaSelvabala, V, Varathachary, T, Kirupha Selvaraj, D, Nandagopal, J, Subramanian, S (2010). Synthesis of biodiesel from Neem oil using sulfated zirconia via tranesterification. Braz. J. Chem. Eng., *27* (4), 601-608.

Global Journal of Science Frontier Research (B) Volume XII Issue VII Version I Year 2012

12. Ndana M, Garba B, Hassan L, Faruk U.Z (2011).Evaluation of physicochemical properties of biodiesel production from some vegetable oils of Nigeria origin. Bayero journal of pure and applied sciences 4(1): 67-71.
13. ODEE, D(1998). Forest biotechnology research in dry lands of Kenya: the development of Moringa species. Dry land Biodiversity **2**, 7 - 8.
14. Ragit, S. S, Mohapatra, S. K, Kundu, K, Gill, P (2011). Optimization of neem methyl ester from transesterification process and fuel characterization as a diesel substitute. Biomass Bioenergy, *35* (3), 1138-1144.
15. Ramachandran, C, Peter, K.V, Gopalakrishnan, P.K (1980). Drumstick (*Moringa oleifera*): a multipurpose Indian vegetable. Economic Botany 34, 276-283.
16. Sneha K. Athalye, Rafael A. Garcia, Zhiyou Wen (2009). Use of Biodiesel-Derived Crude Glycerol for Producing Eicosapentaenoic Acid (EPA) by the Fungus Pythium irregular J. Agric. Food Chem., 57 **(7)**, 2739-2744.
17. Wang, R, Hanna, M. A, Zhou, W.W, Bhadury, P. S, Chen, Q. Song, B.A, Yang, S. (2011). Production and selected fuel properties of biodiesel from promising non-edible oils: Euphorbia lathyris L., Sapium sebiferum L. and Jatropha curcas L. Bioresour. Technol., 102 (2), 1194 -1199.