JASEM ISSN 1119-8362

Full-text Available Online at www.ajol.info and www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage. *September*, 2014
Vol. 18 (3) 371 - 374

Bio-Diesel Production from Oil of Orange (*Citrus Sinensis*) Peels as Feedstock

***[1] BULL, OS; OBUNWO CC**

Department of Chemistry, Rivers State University of Science and Technology, Nkpolu-Oroworukwo, Port Harcourt

KEY WORDS: Biodiesel, Production, Transesterification, Oil, Orange peels, (*Citrus sinensis*), Feedstock

ABSTRACT: Although, in Nigeria orange peels are considered as a waste, this study is intended to convert the waste into wealth by establishing the production of biodiesel with oil obtained from orange peels; using transeterification process. Oil from sun-dried/ ground orange peels were extractedusing n-hexane. Transesterification process was done at a temperature range of80 - 83 °C with oil to ethanol mole ratio of 1:3 respectively and sodium hydroxide as catalyst. The parameters analyzed included: Viscosity, Density and the concentrations of K, Na, Ca, Mg and P.The viscosity and density of the biodiesel obtained were 2.1 stand 825 kg/m^3 respectively. The mean concentrations of K, Na, Ca, Mg and P in the biodiesel were 4 ppm, 7 ppm, 3 ppm, 3 ppm and 8 ppm respectively. These results are in close agreement with ASTM standards requirement for biodiesel. The glycerol was recycled trice before it finally lost potent.It is thus apparent that the locally-sourced feedstock (orange peels) would be a good source for the production of biodiesel. @JASEM

http://dx.doi.org/10.4314/jasem.v18i3.2

The dependence of fossil fuel as a primary source of energy fordomestic and industrial application by most countries of the world has lead to global climate changes, environment degradation and human health problems (IPCC, 2007;Raleigh, and Henrik,2007; ASCC, 2010; Climate Change, 2010; and Held, 2012). Fossil fuels are the largest contributors of green house gases to the atmosphere due mainly to their large use in transportation, electricity and thermal energy generation (Li, *et al*, 2003;IEA 2004;Papasavi, 2005; Slaughter*et al*, 2005). The environment becomes more negatively impacted as a result of increased global consumption of fossil fuel (Raleigh and Henrik, 2007).These gases are responsible for global warming and other negative effects to the ecosystem such as the reduction of dissolved oxygen in oceans, melting of ice caps and glaciers, death of coral reefs and drought (Choi *etal*, 2009; Awake!, 2012).

Worldwide concern and effort have, however, begun in the development of renewable and more economically viable alternative fuel sources in order to cut down dependence on fossil fuel as a primary source of energy for domestic and industrial uses. Some of these alternative and renewable sources of energy include solar energy, hydroelectric power, fuel cells, wind power and bio-fuels(Bouaide, *et al*, 2007).

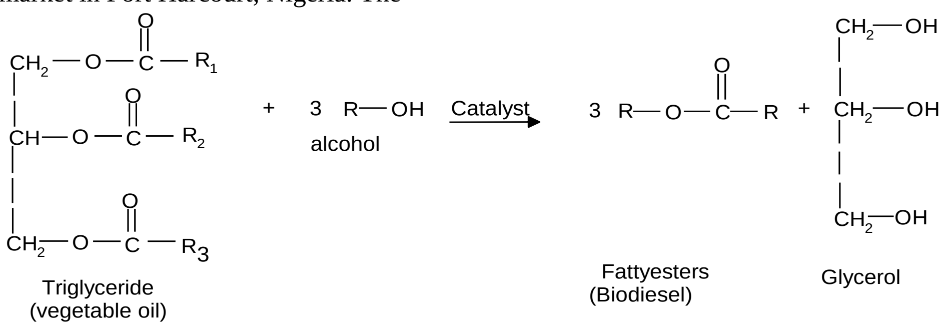
Bio-ethanol and biodiesel are the two well known bio-fuels derived from agricultural crops and products (Ma, 1999).Although bio-ethanol is made by fermentation, mostly from carbohydrates, biodiesel are fuels that are made of mono-alkyl ester of long chain fatty acids derived from vegetable oils or animal fats (Vincent et al, 2007). Biodiesel is non-toxic, biodegradable, produced from renewable sources and contributes a minimal amount of net green house gases, such as CO_2 and NO_2 (Bouaida*etal*, 2007).Thus biodiesel may be considered as a very good and promising alternative source of energy (Demirabas, 2007). The current feedstock of biodiesel production is vegetable oil, animal fat and micro algal oil. Vegetable oils currently being used as a sustainable commercial feedstock oils for the production of biodiesel includes sunflower oil,(De los Rios, 2011) soya bean oil, (Watanabe, 2002, Du, 2004) cottonseed oil,(Wu, 2007, Liang,*et al.* 2010) rapeseed oil, (Kusdiana,2001) peanut oils, coconut oil, palm-kernel oil (Crabbe, 2001, Al Wiyan, 2002) and fried oil (Demirabas and kara, 2006). Most of these oils used so far for the production of biodiesel are edible oils, expensive and may thus be counterproductive if used in large scale for the production of biodiesel (Niotou*et al*, 2008, Yusuf, N. 2011).Thus a dependence on the production of biodiesel from edible oils will result into scarcity of food for man and livestock. This consideration has necessitated the use of non-edible oils from cheap sources such as waste.For example, Rhadha and Manikandan (2011) in their research on the production of biofuel from neem oil discovered

*Corresponding author email address: okpara.bull@ust.edu.ng

that the optimum condition to achieve maximum yield of biodiesel was at a temperature of 55°C and a molar ratio of 1:12 ratio of oil and methanol after conducting their experiment at different temperatures and with different molar ratio of oil and methanol. They determined the kinematic viscosity and acid value of the biodiesel and demonstrated that the biodiesel produce reduced smoke and carbon monoxide emission.

Methodology

Orange peels were collected from local orange traders at a popular market in Port Harcourt, Nigeria. The peels were sun dried for a period of 72 hrs. The dried orange peels were ground to powder form with a manual grinder. With a soxhlet extractor, oil was extracted from the powdered orange peels using n-hexane as solvent. The crude orange peel oil was separated from the n-hexane by allowing the oil mixture to stand under a fan for the n-hexane to volatilize to a constant weight of the oil. The oil was then dried in a hot air oven at 60 °C for 1 hr. The dry oil was then transesterified for the production of biodiesel. Scheme 1 below shows the reaction of transersterification for the reaction.



Scheme 1: Transesterification reaction of vegetable oil and alcohol

Transesterification process was conducted in a reflux system with oil and ethanol mole ratio of 1:3. 30 ml of the oil from orange peels was mixed with 90 ml of ethanol and 1 g of sodium hydroxide (NaOH) in a reflux system equipped with a magnetic stirrer. The mixture was heated at a temperature range of 80- 83 °C for 2 hrs. The mixture was then allowed to settle for 48 hrs at which two separate layers were obtained. A 500 ml separatory funnel was used to separate the ethylester from the other layer. The pH value of the ethylester was tested to ascertain its purity and the purification of the ethylester was done with sulphuric acid. The mixture was then allowed to settle for 72 hrs at which two layers were obtained; the top layer was the ethylester (fatty acid ethylester (biodiesel) (Gerpen, 2004). The produced biodiesel was characterized in accordance with ASTM standards. The glycerol was recycled trice to produce biodiesel with fresh oil for which the process worked well for three sets of experimentation. However, the forth attempts yielded no reliable result in terms of biodiesel production.

RESULTS AND DISCUSSION

From the extraction process, 30.0 ml of oil (produced from 4.5 kg of orange peels) yielded 28.0 ml of biodiesel (i.e. about 93%yield).

Table 1: Physicochemical characteristics of the produced biodiesel

Parameters	Experimental value	ASTM Standard
Density	825 kg/m^3	820-845 kg/m^3
Viscosity	2.1 cst	1.9-6.0 cst
Magnesium	3 ppm	5 ppm
Sodium	7 ppm	5 ppm
Calcium	3 ppm	5 ppm
Potassium	4 ppm	5 ppm
Phosphorus	8 ppm	10 ppm

The physico-chemical characteristic of the produced biodiesel was in good agreement with ASTM standards as depicted by Table1. However, sodium concentration(7 ppm) exceeded the ASTM standard(5 ppm) requirement for biodiesel production. We attribute the increased level of sodium to the introduction of NaOH in the transeterification process and may thus not act adversely to the quality of the biodiesel. Thus, the biodiesel produced could be a good alternative if the content of sodium is removed or reduced to its minimum value, since other parameters measured are in accordance with standard requirements for biodiesel. This implies that bio-diesel can be produced in large scale using oil from orange peels. However, for large scale production of biodiesel using oil of orange peels as feedstock, large amount of orange peels will be required. Analysis carried out on the biodiesel produced showed that the biodiesel made with oil from orange peels has its content of K,Mg,Ca, and P as 4 ppm, 3 ppm, 3 ppm and 8 ppm respectively. This result is in agreement with ASTM standard requirement for biodiesel and as well compares to biodiesel produced from neem oil(Radha, and Manikandan, 2011), sunflower oil, (De los Rios, 2011),soya bean oil, (Watanabe, 2002, Du, 2004) cottonseed oil, (Wu, 2007, Liang, *et al.* 2010) rapeseed oil, (Kusdiana, 2001) peanut oils, coconut oil, palm-kernel oil (Crabbe, 2001, Al Wiyan, 2002) and fried oil (Demirabas and kara, 2006)except for slight difference in sodium content (7 ppm) which is above the ASTM standard (5 ppm) requirement for biodiesel. Thus, the biodiesel produced could be a good alternative if the content of sodium is removed or reduced to its minimum value, since other parameters measured are in accordance with standard requirements for biodiesel.

*Conclusion***:** This finding suggest that the condition of orange peels oil biodiesel produced were 1.3 oil to ethanol volumetric ratio, 1g NaOH at 80 - 83 °C reaction temperature. The study provides evidence that oil from orange peels might be employed as a substantial feedstock for the production of biodiesel that can be used as fuel in diesel engines. This is because; the produced biodiesel was of good quality within the array of ASTM standard method specification.

REFERENCES

Advancing the Science of Climate Change (ASCC) (2010), National Academic Press, Washington, D.C,

Awake! September,(2012) Doomsday, Fact, Fiction and Fantasy.

Al Widyan, M(2002). Experimental evaluation of the transeterification of palm oil into biodiesel.*Bioresour. Technol.* 85, 65-74

Bouaide, A. Martineze, M. and Aracil, J. (2007). Long Stability of Bio-diesel from vegetable and used frying oils; Fuel 86: 2596-2602.

Climate Change (2010): a Summary of the science, The Royal Society, London

Choi, S. Drese, J. H. and Jones, C .W (2009).*ChemSusChem*,2,796 - 810 (DOI:10.1002/cssc.200900036).

Crabbe, E. (2001). Biodiesel production from crudepalm oil and evaluation of butanol extraction and fuel properties. Process biochemistry 37: 65-80

De los Rios A. (2011). Biocatalytictransesterification of sunflower and waste cooking oils in ionic liquid media.*Process biochemistry 46: 1475-1498*Demirabas, A. and Kara, H. (2006). New option for conversion of vegetable oil to Alternative fuel, energy sources, part A Recovery. Utilization and environmental effect 28:619-626.

Demirabas, A. (2007). Recent development in bio-diesel fuels int.J. Green energy 4:15-26.

Du, W. (2004).Comparative study on lipase-catalysed transformation of soybean oil for biodiesel production with different acyl acceptors. Journal of molecular catalysis, B, Enzymatic 30: 125-170

Ganesan, D (2009). An overview on the recent advances in the transesterification of vegetable oils for the biodiesel production using chemical and biocatalysts.Reviews in environmental sciece and biotechnology 8: 367 – 387

Held, I. (2012).*Nature Geoscience*, 5:236 (DOI:10.1`038/ngeo1436).

IEA, (2004).world energy outlook 2009, Paris France international energy.

Intergovernmental Panel on Climate Change (IPCC) (2007), in Synthesis Report, ed. Cambridge University Press Uk.

Li, N., Hao, M., Phalen, R.F., Hinds, W.C., and Nel, A.E (2003). Clinical Immunology, 109: 250-265 (DOI:10.1016/j.clim.2003.08.006)

Liang, J; Wang, J; Jinag, M and li, Z. (2010).Preparation of biodiesel by transesterification from cottonseed oil using the basic dication ionic liquids as catalyst. J. Fuel Chem. Tech. 38(3) 275-280

Kusdiana, D. (2001). Kinetics of transesterification in rapeseed oil to biodiesel fuel as treated in supercritical methanol. *Fuel*: 80: 693-704

Ma, F. (1999). Biodiesel production: a review. Bioresour. Technol. 70: 1-20

Niotou, A.A. Kantarellis, E.K. and Theodoropolus, D.C. (2008). Sunflower shells utilize for energetic purpose in integrated approach and kinetics. Biores tech 99: 3174-81

Narjis, H. M. AL.saadi, N. S. shaima, S.E. (2009). Some Chemical Compounds and the effect of oil extract from orange peel on some pathogens.

Raleigh, C. and Henrik, A. (2007). Climate change environment degradation and armed conflict.

Radha, K.V. and Manikandan, G. (2011).Novel production of Biofuels from neem Oil world renewable energy congress 2011-Sweden.

Slaughter, J.C., Kim, E., Sheppard, L, Sullivan J. H., Larson T.V. and Claiborn, C. (2005).*J. Expo. Anal. Environ. Epidemiol.*, 15: 153-159 (DOI:10.1038/sj.jea.7500382)

Tapasvi, D. (2005) Process model for biodiesel production from various feedstocks.Trans. ASAE 48: 2215-2220

Vincent, G. Martinez M, and Aracil, M. (2007).Optimization of integrated biodiesel production.Part 1 A study of the biodiesel purity and yield biores. Tech **95** 1742-1833.

Watanabe, Y. (2002) Conversion of degummed soybean oil to biodielful with immobilized candida antarctica lipase. *Journal of molecular catalysis. B,Enzymatic*,17: 151-160

Wu, Q. (2007). Transeterification of cottonseed oil catalysed by bronsted acid ionic liquids.*Industrial engineering chemistry research 46, 7955*

Yusuf, N. (2011). Overview on the current trends in biodiesel production.*Energy conversion and management 52: 2741-2776*