NON-EDIBLE BABASSU OIL AS A POTENTIAL FEEDSTOCK FOR BIODIESEL PRODUCTION

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ABSTRACT

Babassu oil is extracted from the seeds of the babassu (Orbinya sp), and because of its higher fatty acid composition (83%), it is a inedible oil. Transesterification using methanol represents a valid alternative biodiesel with higher yield and less toxicity. Various methodologies are applied to optimize the transesterification reaction, that was promoted by high frequency waves and mechanical agitation. Transesterification assisted by ultrasound created the most effective results with reference to response time and in the separation step. The model obtained showed that conversions above 90% could also be achieved within 10 min with correct standardisation of the different variables. The biodiesel production from a mix of those alcohols may be a means of adding the technical and economical benefits with the environmental advantages of ethyl alcohol. The methyl esters synthesis from babassu oil and methanol using potassium methoxide as catalyst has developed. The different variables affecting the methanolysis of babassu oil were studied. Reaction temperature was found to most effective on conversion. In this study it is observed that for cost effective purpose o, the most effective conditions for overall methods are catalyst concentration of 0.95% at operation temperature of 45°C operating with 6:1 methanol/oil molar ratio. With these conditions up 99.85% conversion can be obtained. The babassu oil methyl esters (BME) could be used as a highly promising substitute for conventional fuel possibly as its properties are within limit with high oxidative stability displayed and matching the Biodiesel Standard

Keywords: Babassu Oil; Methyl Esters; Style; Biodiesel; Physicochemical Properties.

I. INTRODUCTION

The contribution of non-edible oils such as babassu, a generic name given to palm oil belonging to the Palmae family and members of the genera Orbignya and Attalea, dispels biodiesel production issues related to the use of edible vegetable oils. Babassu oil constitutes 66% of the babassu kernel weight, with 83% of the grease composition made up of saturated oils, making it an excellent candidate for biodiesel production [1]. Biodiesel is defined as a fuel composed of alkyl esters of long chain fatty acids, derived from vegetable oils or animal fats [2]. Considering the millions of hectares of tropical forests with a great amount of babassu palm trees and the possibilities of the integral usage of the coconut, babassu potentially constitutes an extraordinary raw material source for biodiesel production; meanwhile the other parts of the tree can be used for other purposes. In addition, it is more reasonable to use inedible oil such as babassu oil, as edible oils are not in surplus supply [3]. babassu kernels (Orbignya phalerata) contain one or two seeds with a white oily endosperm.[4] the biodiesel chain production is potentially promising for distinct and essential areas such as social, environmental and technological. The oil that accounts for 7 % of the total mass of the fruit is the main commercial product extracted from the babassu nut In numbers, the processing of babassu employs about 4 million people, covering 16.5 million hectares, producing 7 million tons per year, with an estimated potential of 15 million tons per year[5]. An alternative fuel to petrodiesel must be technically feasible, economically competitive, environmentally acceptable, and easily available. The current alternative diesel fuel can be termed biodiesel. Biodiesel can offer other benefits, including reduction of greenhouse gas emissions, regional development and social structure, especially to developing countries [6].

Babassu oil has excellent characteristics for biodiesel production because its composition is predominantly lauric (C12:0) acid. However, data on babassu oil is limited, and a more detailed study of its rheological properties is needed because of its predominantly saturated fatty acid composition[7]. The babassu is a promising feedstock, which kernel is constituted of 66% by weight of oil of predominantly saturated composition (83%), factors that makes of this oil an excellent candidate for biodiesel production[8]. It is important to mention that in case biodiesel turns out to be an industrial reality, a surplus of approximately 25 thousand tons of glycerol per year is expected to exist in the market (considering demand of 20 thousand ton/year), becoming strictly necessary to develop new applications for low cost glycerol available from biodiesel units operation. The present work also looks for this supply through the proposition of an enzymatic technology for using this by-product to obtain high value added compounds[9]. Babassu (Orbignya phalerata or Orbignya oleifera) is a palm tree (up to 20m in height), which is found naturally in Brazil and Colombia. The main products are fruits which are small coconuts that hang from bunches, 4 per tree per season, with about 20 coconut fruits each[10,11]. The oil content of babassu almonds is around 66%. The name babassu refers to three different species in the Palmae family: Scheelea, Attalea and Orbigny, where the common babassu name generally refers to Orbignya phalerata, and in a limited region Orbignya oleifera[12,13]. This work proposed ethanolysis of babassu oil employing the alkaline hydroxides most commercially used, the sodium and potassium hydroxides, which were evaluated independently. The aim was to study the process performance aided by statistical methodology[14]. The cusi oil extracted from the seeds of these palms, which are basically consist of saturated fatty acids, such as lauric (48 %), myristic (16 %), palmitic (10 %) of other unsaturated, is an important source for the production of Biodiesel[15,16]. Lauric acid, present between 40% and 55%in babassu oil, also has pharmacological properties; like reduc-tion of the HIV viral load in postpartum mothers and newbornswhen the patients diets are supplemented with it. The kernelcake is rich in carbohydrates and proteins, which make up between 90% and 95% of its total content. It is often used as an organicfertilizer and in large quantities as a feed supplement for peccaries[17,18]. The viscosity of a fluid plays a major role in its pumping and flow within an engine. The desirable viscosity for diesel oil at 37.8°C ranges from 1.9 to 4.1 cSt [19,20]. Thus, it is necessary to check the efficiency of processing babassu oil into biodiesel, since previous studies found that the physicochemical properties of the extracted oil from babassu are suitable for fuel production[21].

1.1 Objectives:

The objectives of the present review are:

(a) To explore the possibility of Babassu methyl ester (BME) by using Babassu oil.

(b) To study the various methods of biodiesel preparation.

(c) To study the different properties of Babassu oil and BME.

1.2 Feedstock for biodiesel

The ethanolysis of babassu oil is presented as a source for biodiesel production, employing the most commercially used hydroxides, sodium and potassium, which were evaluated independently[1]. Babassu oil displays a high percentage of saturated fatty acids, 91%, mainly composed of lauric acid, myristic acid , palmitic acid, stearic acid and others. It also presents 19% of unsaturated fatty acids, chiefly oleic and linoleic acids[2]. The current technological progress, potential reserves, and increased exploitation leads to energy insecurity and climate change by increasing greenhouse gas (GHGs) emissions due to consumption of energy at a higher rate. The use of fossil fuels is now widely accepted as unsustainable due to depleting resources and the accumulation of GHGs in the environment that have already exceeded the “dangerously high” threshold of 450 ppm $CO_{2.}$ [5] One key aspect in the exploitation of the babassu is the collecting and gathering system. There are no plantations of these palm trees, so the fruits have to be collected from natural woodlands by the indigenous population. In the case of Brazil, fruits are collected and broken[22-24]

II. PRODUCTION OF BABASSU OIL METHYL ESTER

The procedure for the transesterification reaction starts by dissolving KOH in the methanol/ ethanol blend, under stirring at room temperature. Next, add to this solution 100 g of oil under stirring and allow the reaction up to the phase separation. Remove the alcohol excess by distillation under reduced pressure. Transfer the mixture of esters and glycerin to a separatory funnel and allow settling for 12 hours. Afterwards, separate and weigh both phases and wash the biodiesel, using the air bubbling technique.

Table I Physico-chemical Properties of Babassu oil

Sr No.	Researcher→ / Properties ↓	Eduardo et al. [1] Silva et al. [2]	Bouaid et al. [3]	Bianca et al. [4]	Patricia et al.[17] Maria et al.[20]
1	Density (gm/cc@25^{0}C)	0.923		0.920	
2	Viscosity Cst@40^{0}C	34.40	38.28		
3	Saponification value (mg KOH/g)			236.9	233.77
4	Acid value Mg KOH/gm		0.15	0.592 meq/100g	0.505 meq/g
5	Iodine value mg iodine/gm		18	18.3	
6	Molecular wt. g/mol	709.90			709.90
7	Moisture and sediments (% v/v)	0.039	0.02		

The best reaction conditions to obtain methyl and ethyl babassu biodiesel were determined by Silva and Brandão: oil/methanol molar ratio of 1:4.6, KOH content of 1.5 %, 30 min of reaction time, stirring of 1760 rpm and room temperature. The biodiesel produced from babassu oil can be used as a diesel fuel substitute since it meets the European Biodiesel Standard EN14214. Some of the important quality parameters of biodiesel viscosity, acid value, ester contents, cloud point, pour point and oxidative stability for the optimum reaction conditions are shown in Table II.

Table II Physico-chemical Properties of Babassu oil Methyl Ester (BOME)

Sr No.	Researcher→ / Properties ↓	Silva et al. [2]	Bouaid et al. [3]	Silva et al. [5] Ayhan et al. [6]	Patricia et al. [15]	Thulio et al. [16]	Maria et al. [20]	Rondinelly et al. [21]
1	Density gm/cc@25^{0}C	0.8872		087	0.870	0.875	0.88	0.88
2	Viscosity Cst@40^{0}C	4.830	2.98	3.6	4.2	3.42	4.0	
3	Cetane number			63	63.7			
4	Flash point ^{0}C			120		118	112	120
5	Moisture %	0.028	0.02					
6	Pour point ^{0}C		-6	2				
7	Sulphur content ppm			00			0.003	
8	Cloud point ^{0}C		-4	-6				
9	Cloud filter plugging point (CFPP)		-8	-9	-8.5			

III. QUALITY CONTROL OF BABASSU OIL METHYL ESTERS

The biodiesel produced from babassu oil can be used as a diesel fuel substitute since it meets the European Biodiesel Standard EN14214. Some of the important quality parameters of biodiesel viscosity, acid value, ester contents, cloud point, pour point and oxidative stability are important for the optimum reaction conditions. The measured values were in agreement with European Union Standard EN14214. The kinematics viscosity is in between 2.98 mm2/s to 4.83 at 40°C and is within the range specified in EN 14214. The acid values are also within the maximum 0.5 mg KOH/g set in EN14214.BME gives a cloud point (CP) of -4, a pour point (PP) of -6 and a cold filter plugging point (CFPP) of -8 to -9, these values are relatively low. This results may be justified due to the lower melting points of babasu methyl esters components such as methyl caprylate , and methyl caprate with a melting point of (-37.3°C) and (-13.1°C) respectively. The BME is suitable to be used as biodiesel either in hot and cold weather. It may be noted that the cloud point CP is the parameter contained in the biodiesel standard ASTMD6751, while the European standard EN 14214 prescribes the cold filter plugging point (CFPP). The CP can be correlated with tests such as the CFPP and is more stringent as it relates to the temperature at which the first solids form in the liquid fuel. Oxidative stability of BME was determined by the Rancimat method EN14214, the average of two tests was 8.32 h. Thus, BME met the oxidative stability requirements in the EN14214 standard. Although BOME contain only a low amount of unsaturated esters compared to saturated ones, the oxidative stability of BOME is influenced by these unsaturated esters. This observation has been predicted in the literature. However, the nature and physicochemical properties of the BME composition, and the presence of mono-, diglycerides (intermediates in the transesterification reaction) and/or glycerol, may play a major role in oxidative stability and cold flow properties.

IV. CONCLUSION

The babassu oil has shown excellent qualities as a raw material for biodiesel. Even in ethanolysis reaction this oil gives similar behavior of the reactions that used methanol present in the literature. The experiments showed that the right combination of the variables promote higher conversions into methyl esters. The methanol to oil ratio is a important factor for transesterification. The simplest conversion and separation conditions were obtained with the proper utilization of KOH. Comparison shows that the reaction and separation times are significantly reduced with the utilization of ultrasound method. The study of the factors affecting the response shows that, within, the experimental range considered, the most important factor is the temperature reaction. It has been found that biodiesel, produced by transesterification of babassu oil using methanol as alcohol could improve biodiesel operability in cold weather. The biodiesel sample shows a high oxidative stability and displays physical-chemical properties suitable for use as diesel car fuel. As a sustainable fuel, babassu oil is promising because it is only harvested in the wild from tropical rain forests so it does not contribute to de-forestation. The shells of the fruits can also be used as biomass for fuel after the oil plant has been harvested.

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