

Recovery of Waste Cooking Oil Used in the Biodiesel Production in Ecuador

¹Herminia Sanaguano Salguero, ²Angélica Tigre León, ²Araceli Lucio Quintana, ^{*}Favian Bayas Morejón

1. Centro de Investigación Ambiental, Departamento de Investigación, Universidad Estatal de Bolívar, 020150, Guaranda-Ecuador
2. Centro de Investigación y Desarrollo Biotecnológico, Departamento de Investigación, Universidad Estatal de Bolívar, 020150, Guaranda-Ecuador

*Corresponding author: favian.2bm@gmail.com; fbayas@ueb.edu.ec

Abstract: Considering that, the waste cooking oil in the river water causes oxygen levels to drop drastically, and that few data are currently available about the harnessing of these oils in the biodiesel production, and that nowadays, alternative fuels have received much attention due to the depletion of world petroleum reserves. The aim of the present study was to evaluate and recovery of cooking oil used by the biodiesel production. To this effect, an alkali-catalyzed transesterification of 15 waste cooking oil samples, collected in Guaranda city, Ecuador was carried out in a laboratory scale. All samples presented accepted saponification values (from 268 to 274 mg KOH/g oil) to the transesterification process. Nine combinations (treatments) were analyzed and only one treatment (T2: showed high yield 63.15%. Parameters how capacity to produce heat, moisture content, specific gravity, flash point and viscosity, were quite like that obtained of the petrodiesel.

Index Terms: Biodiesel production, recovery, waste cooking oil, Ecuador.

1 INTRODUCTION

Biodiesel is superior to conventional diesel in terms of its Sulphur content, aromatic content and flash point. It is essentially Sulphur free and non-aromatic while conventional diesel can contain up to 500 ppm SO₂ and 20–40 wt% aromatic compounds [12], these could be a solution to reduce the problem of urban pollution.

The increase domestic fryers and restaurants of fried foods allowances implies a substantial generation of fatty and oils. Those that due to the lack of a norm of regularization and to the environmental conscientious lack, this are thrown in a form direct in the line of municipal drainage, or to the systems of gathering of garbage, causing serious problems of contamination [1]. This phenomenon of environmental contamination is very common the Ecuadorian cities and Guaranda are not the exception. Recently, the European Union is very critical to the biofuel production using edible oils such as palm oil, corn, soybean and maize, which are consumed as food [6], and this organism see the importance in recovery waste cooking oil, to prepare biodiesel or other sub product. In fact, our research group have been working in the use of

waste cooking oils, to make soap and shampoo how an alternative of waste use in Guaranda Ecuador [16].

The main generators of these residuals they are the industries of fritters, and establishments of preparation of quick food, and restaurants.

Biodiesel has been described as a fuel composed of monoalkyl esters of long-chain fatty acids derived from renewable vegetable oils and fats [17]. In the actuality, these products have major importance, because the transportations fuel that has gradually grown, and the decreasing reserves of fossil fuels, it can be this way an alternative to substitute to the fossil fuels [2]. The frying the recycled oils can be very heterogeneous as comparative to the raw or refined oils. In general, it is found that the raw oils have more than 95% of glycerides of the triglycerides partial that would give more than 98% of fatty acid methyl esters FAME [15]. The non-altered FAME depends on the fickle quality of the used one frying the oil [16]. Chemically, biodiesels are produced from the transesterification of triglycerides found in vegetables oils and fats to form the monoalkyl esters, which are the primary molecules of biodiesel [14]. Alkali catalysts used in transesterification can be potassium hydroxide (KOH), sodium hydroxide (NaOH), alkali methoxides, Sulfuric acid (H₂SO₄) and hydrochloric acid (HCl) [12]. However, the choice of catalyst depends on the free fatty acids (FFA) content in the feedstock oil. Alkaline-catalyzed transesterification is

• Herminia Sanaguano, Chemical Dra. is currently pursuing doctoral degree program in Environmental Sciences in Mayor San Marcos University, Peru. E-mail: hrosario@hotmail.es

• Angélica Tigre, Agroindustrial Eng. is currently working in State University of Bolívar, Ecuador. E-mail: roan_t@yahoo.es

• Araceli Lucio, Ph.D. is currently is researcher and vice-chancellor Academic and Research in State University of Bolívar, Ecuador. E-mail:

• Favian Bayas, Ph.D. is currently researcher in State University of Bolívar, Ecuador, PH-593+0968425039. E-mail: <http://www.ijser.org>

much faster than acid-catalyzed transesterification and thus most often used [3].

The use of biodiesel maintains a balanced carbon dioxide cycle as it is based on renewable biological materials. Besides, environmentally friendliness due to reduced emissions (Carbon monoxide, Sulphur and Aromatic hydrocarbons) during combustion is of another benefit; also, it offers non-toxic and complete biodegradable properties [13].

Considering all previously described the objective of this study was to define the useful analytic methods to obtain biodiesel with the help of oils eatable residuals of Guaranda city, whereas clause present compounds in the raw material.

2 MATERIALS AND METHODS

2.1 Samples preparation

Five teen recovery cooking oil "RCO" samples were collected from five domestic fryers and restaurants of the city of Guaranda Ecuador, 250 mL from each sample were filtered in a membrane filter of 0.4 μm; and the sediments were eliminated. The samples had saponification values ranging from 268 to 274 mg KOH/g oil.

2.2 Transesterification and treatments analysis

Nine combinations were analyzed, NaOH in three concentrations were used how catalyst (1, 2 and 3 %) and three concentrations of Alcohol (25%, 50% and 75%).

We considered oleic acid how more predominant, this for the oil vegetable origin, the molecular weight was 282.16 g/mol [11].

In the transesterification 250 ml of RCO was decanted and filtrated than was necessary the preparation of ethox solution (ethylic alcohol 25 -50 -75% and NaOH 1- 2 and 3%), the mixture was allowed to left for 24 hours. After 24 hours of separated the RCO was heated for 5 minutes, at 50°C ±2, then oils were mixed with ethox solution, this varied between 52 mL and 156 mL.

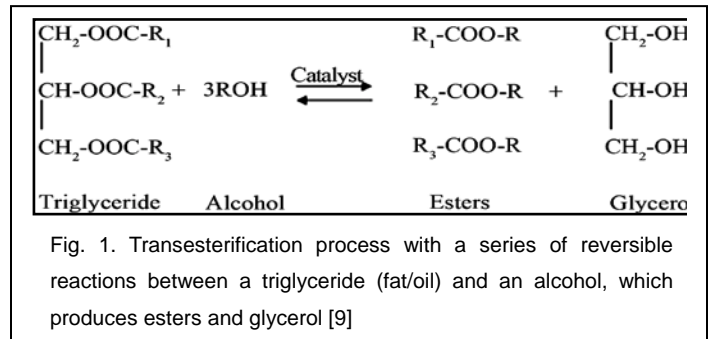
First homogenization

The mix was homogenized at 800 rpm for 30min in a magnetic stirrer of heat (Corning PC-420D Stir USA), and 98% of H₂SO₄ was added (A300C-212 Fisher Scientific USA) in a relation 1% with respect to RCO volume (250mL).

Second homogenization

A second homogenized was carried out at 800 rpm for 30 minutes, the mix was decanted in a funnel (Pyrex 275 – 1000ml M6402 Germany), the mixture was allowed to left for 24 hours at room temperature. After this time, the caps were separate.

The major combination (treatment) was obtained by means of the best yield about the volume of biodiesel and smaller consumption.



2.3 Analysis in the biodiesel obtained

The titratable acidity was determinate by the method ASTM D 664 according to the norm NTE INEN 2482 [11]. The formula applied was,

$$\%FFAx = \frac{\text{mL via} \cdot M \cdot N}{10 \cdot \text{sm}} \quad (1)$$

Where: % FFA= percentage of free fatty acids; mL via= milliliters worn-out solution, M= mass of predominant fatty acid; N= Normality, 10= Constant; sm= Sample volume.

The density was obtained by using pycnometer (Obero 1 10mL UK), the formula used was,

$$d_{25} = \frac{w_2 - w}{w_1 - w} \quad (2)$$

Where: d_{25} = relative density at 25/25 °C, w = weight of pycnometer empty, w_1 = weight pycnometer + distilled water, w_2 = weight pycnometer + sample.

The flash point was determinate by the standard (ASTM D93) and using a lamp of alcohol, and a caldera, pH was analyzed by using indicative paper (Mecherey-nagel pH-Fix 0-14PT 92111 Duren Germany), viscosity was determinate by standard (ASTM D445) according to the norm INEN 2 482: [11], moisture content (ASTM D2709) and specific gravity (ASTM D287). The results were compared with commercial petrodiesel.

2.4 Statistics Analysis

To description of treatment, was applied the experiment designer by use of statistics software InfoStat/L free version [7]. Were applied an experimental designer of block with factorial arrangement A to B.

3 RESULTS AND DISCUSSION

The proportion of the ethanol/oil is one of the most important factors in the biodiesel elaboration affecting the biodiesel yield. Although the proportion of the stoichiometric requires a proportional relationship 3:1, the transesterification is usually take outside with an extra quantity of alcohol to change the balance to the proposed product, the ester of the methyl. According to Centikaya and Karaosmanoglu [3], for this effect we have developed a solution of ethanol (ethoxic solution) to contribute to the good chemical balance that the transesterification requires.

The iodine value is not too high showing that biodiesel obtained from waste cooking oil may not be too susceptible to oxidation and quick rancidity, in the oils were between 121.58 and 122.05 g/100g.

3.1 Yield of the combinations

The result of the oil quality parameters shows that residual cooking oil could serve as an economic feedstock for biodiesel production given the percentage oil yield between 0.11to 63.15%. Of the nine combinations analyzed, only the combination 2 (1% NaOH and 50% alcohol) showed a high yield (63.15%) (Table 1). Considering data from literature, the concentration of hydroxide tested is between 0.5 and 1.5 wt% of Waste Cooking Oil with the conversion of methanol [12].

TABLE 1
VOLUME IN ML OF BIODIESEL OBTAINED

Combinatio ns	NaOH (%)	Alcohol (%)	Vol. glycerine	Vol. biodiesel in mL (yield)
1	1	25	113	140 (44.09%)
2*	1	50	115	240 (63.15%)
3	1	75	123	230 (51.97%)
4	2	25	95	160 (50.00%)
5	2	50	85	220 (57.51%)
6	2	75	105	200 (44.94%)
7	3	25	215	42 (13.00%)
8	3	50	259	0.5 (0.12%)
9	3	75	259	0.5 (0.11%)

* = Better treatment

In the fig 2, it observed that, as it diminishes the quantity of

glycerin more is the volume of obtained biodiesel. Moreover, that the concentration of alcohol is better to 50%, with single 1% of Na OH in the catalysis, transforming to the combination 2.

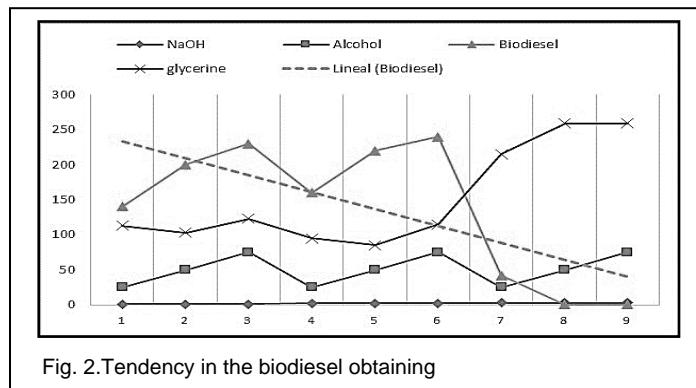


Fig. 2. Tendency in the biodiesel obtaining

3.2 Effect of concentration of NaOH

In previous studies revealed that, the optimum concentration of sodium hydroxide was 0.6 wt% [4]. However, these values were lower than the finding of Leung and Guo [8], and Georgogianni et al. [5], in other study development by Phan and Phan [12], showed that the optimum value of NaOH concentration for neat canola oil and used frying oil was 1.0 wt% and 1.1 wt%, respectively. The authors concluded that the concentration of alkali catalyst is strongly dependent on the type of oils used.

In our study, also can to corroborate with the analysis carried out by these authors. However, in our case we used and blended fritter oil, what forced to carry out a previous treatment to their use, and being achieved with success to obtain biodiesel with alone a concentration of NaOH of 1% Wt%, being the first time in obtaining biodiesel with the use of waste cooking oil with minimum concentrations of catalysis.

3.3 Analysis in the biodiesel

The result of the biodiesel quality parameters of the biodiesel from waste cooking oil are shown in the table 2.

TABLE 2
FUEL QUALITY PARAMETERS OF A PETRODIESEL AND BIODIESEL FROM WASTE COOKING OIL

Parameters	Petrodiesel	Biodiesel from waste cooking oil	
		STCA	STOA
Acid value	--	0.51	0.51
Moisture content (%)	0.05	0.04	0.05
pH	--	6.5	6.5

Specific gravity (g/mL)	0.85	0.87	0.87
Flash point (°C)	60-80	120-150	120-150
Viscosity (mm ² /s)	4.2	5.4	5.8
Density	--	0.895	0.886

STCA = storage low temperature to closed atmosphere
STOA = storage low temperature to open atmosphere

According to the norm: NTE INEN 2482 [11], the specific acidity is 0.5; this way the treatment required bigger quantity of the basic agent, due to the discharge presence of fatty acids in the biodiesel, this for effect possibly to the combination of oils of different origins. The acid value content is highly reduced and moisture is similar with that of petrodiesel. It is evident that transesterification has drastically reduced the moisture content and acid value waste cooking oil giving the produced biodiesel better fuel characteristics.

The admitted pH according to the norm: NTE INEN 2482 [11], is from 5-8, in our work due to the regulation of pH with a solution of Na OH 1M this he/she stayed in a mean value of 6.5; our results are inside of the established range in the norm. The specific gravity of the produced biodiesel compares well with that of petrodiesel, also is like 0.92 obtained by Gimbut et al. [6].

The flash point is higher than that of the petrodiesel making it safer for storage and transportation. The specific gravity of 0.87 shows that the biodiesel is a good energy source.

The viscosity of the biodiesel is of 5.4 and 5.8 mm²/s in the biodiesel, a value that is comparable to that of the petrodiesel.

A flame and combustion analyses were carried out to determine the changes in the combustion characteristics and efficiency of the fuel according to the source of the same one, by means of consumption speed in lighter and capacity of producing heat (table 3 and figure 3).

TABLE 3
FLAME AND COMBUSTION

	Flame		Proves
	T2	petrodiesel	Caldero
Emission of gases	low	high	Med
Time of combustion in lighter (250mL)	7 min	8 min	15 min

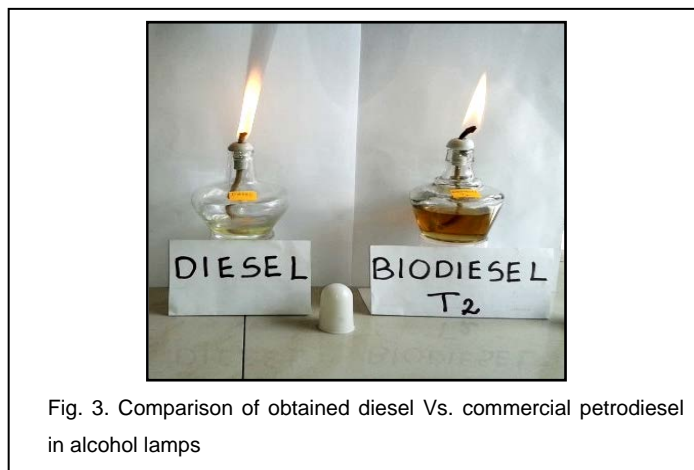


Fig. 3. Comparison of obtained diesel Vs. commercial petrodiesel in alcohol lamps

It was obtained positive results as for the combustion of the samples, where one can say that when using our pure alternating fuel or in combination be obtained good source of heat and less emission of gases. The suitability of the produced methyl esters as a biodiesel is better appreciated when these parameters are compared with that of a standard petrodiesel.

4 CONCLUSIONS

The fuel quality parameters of the biodiesel from cooking waste oil show that it conforms to standards for biodiesel and compares very well with a standard petrodiesel. The cooking waste oil can serve a good feedstock for the elaboration of biodiesel.

ACKNOWLEDGMENT

The authors express gratitude to the Departamento de Investigación de la Universidad Estatal de Bolívar for his support in this work.

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