PASSIFLORA EDULIS SEED OIL METHYL ESTER AS A POTENTIAL SOURCE OF BIODIESEL

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Abstract
The fact that fossil energy reserves are limited coupled with the environmental pressure resulting from their use has encouraged research on biodiesel and other biofuels. Biodiesel is a nontoxic, biodegradable and renewable source of energy made by the transesterification of oils or fats with short chain alcohols. This study was focused on the use of *Passiflora edulis* seed oil (Passion fruit).This oil was obtained from an industrial fruit juice processing waste. The oil was evaluated as a good potential feedstock for production of biodiesel. In this study *Passiflora edulis* seed oil was successfully transesterified using methanol and KOH as a catalyst.A biodiesel yield of 80% was obtained. The biodiesel had a viscosity of 4.60 mm^2/s, acid value 0.45 mgKOH/g, density of 0.89g/ml, colour 1.60, water content 0.2%, copper strip corrosion-No tarnish, and flash point > 150 ^0C .The fuel parameters measured were within range according to the American Society for Testing and Materials (ASTM) and International Standards Organization (ISO) test methods apart from the percentage water content.

Key words: *Passiflora edulis* seed oil, biodiesel, transesterification, catalyst

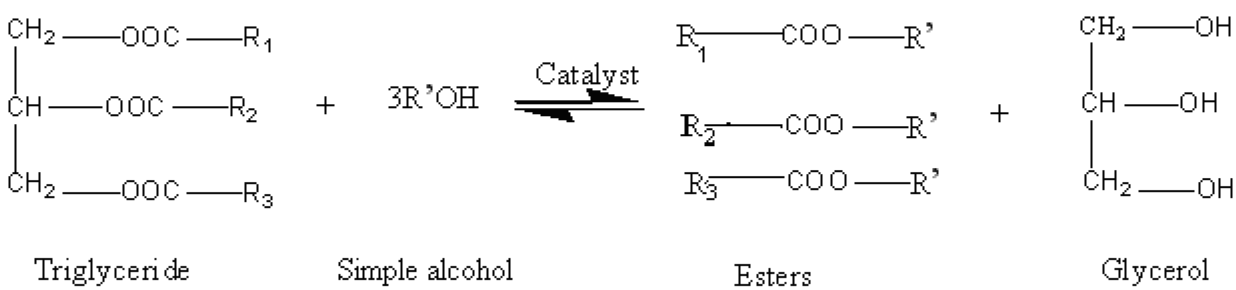
1.0 Introduction

The predicated shortage of fossil fuel coupled with the increase in fuel prices has encouraged the research for other substitutes such as biodiesel. Biodiesel can be defined as the alkyl ester of fatty acids, made by the transesterification of oils or fats, from plants or animals, with short chain alcohols such as methanol and ethanol (Pinto *et al*., 2005). Besides being renewable, biodiesel can also be used directly in most diesel engines without requiring extensive engine modifications (in contrast to other "eco-fuels" such as hydrogen). Other advantages include reduced CO, hydrocarbons, and particles in exhaust emission.Table1 (Kiss *et al*., 2005) shows the average emissions compared to conventional diesel where B20 means a blend of 80% petroleum diesel and 20% biodiesel and B100 means biodiesel in its pure form.

Table 1: average biodiesel emmisions compared to conventional diesel

Emission type	B20	B100
Total unburned hydrocarbons	−20%	−67%
CO	−12%	−48%
CO_2	−16%	−79%
Particulate matter	−12%	−47%
NO_x	+2%	+10%
SO_x	−20%	−100%
Polycyclic aromatic hydrocarbons (PAHs)	−13%	−80%
Nitrated PAHs	−50%	−90%

There have been many problems associated with using vegetable oils directly in diesel engines. These problems include decrease in power output and thermal efficiency of the engine; oil ring sticking; thickening or gelling of the lubricating oil as a result of contamination by vegetable oils. Another disadvantage of the use of vegetable oils directly is the high viscosity (about 11–17 times higher than diesel fuel) and lower volatility that result in carbon deposits in engines due to incomplete combustion (Pinto *et al*., 2005).Transesterification is widely used to reduce vegetable oil viscosity with most industrial processes employing alkaline catalysis and methanol. The transesterification process reduces the molecular weight in relation to the triglycerides, and also, reduces the viscosity improving the volatility. A basic transesterification reaction can be shown as:



After the reaction, the products are a mixture of esters of fatty acids, glycerol, alcohol, catalyst and a low percentage of tri-, di and monoglycerides. There are over 500 species worldwide of Passiflora in the family passifloraceae. Of these the fruits of only about 20 varieties are edible and only about four varieties are cultivated on a large scale, one of them being ,*Passiflora edulis* Sims which has the most significant commercial value (Nyanzi, *et al*., 2005). Two subvarieties of *P.edulis* Sims namely the purple passion fruit (*P.edulis* Sims Var. *edulis*) and the yellow passion fruit (*P.edulis* Sims Var.*flavicarpa*) grow in Kenya. The aim of this research was to produce biodiesel from *Passiflora edulis* seed oil obtained from industrial fruit juice processing waste.

2.0 Materials and Methods

The reagents used were of analytical grade .Methanol, 2-propanol were purchased from Sigma (Seelze, Germany). Potassium hydroxide was obtained from Rankem (New Delhi India). Toluene was obtained from Merck (Barcelona, Spain). The vegetable oil was pressed from dry *Passiflora edulis* seeds which was an industrial waste from a fruit processing plant in Kenya. The acid value of the crude oil was first established before any reaction was performed on it.

2.1 Determination of Acid Value

The acid value for the vegetable oil was determined by the method described by Gerpen *et al*., 2004. Two 250ml beakers were prepared by adding 62.5ml of solvent .The solvent consisted of 50% isopropyl alcohol and 50% toluene.2.5g of the crude vegetable oil was added to one of the beakers (sample beaker) and the other beaker left with out a sample (blank beaker). Both beakers were titrated with 0.1N KOH to the first permanent pink color using 2 ml of phenolphthalein as an indicator in each. The procedure was done in triplicate and the average obtained. The acid value (AV) was calculated using the equation,

Acid Value = $(A-B) \times N \times 56.1/W$ where,

A = Number of ml of KOH needed to neutralize sample beaker, B = Number of ml of KOH needed to neutralize blank beaker, N = Normality of KOH solution, W = Weight of sample used and % F.F.A =1/2 Acid value.

2.2 Transesterification Reaction

The transesterification reaction of *Passiflora edulis* seed oil with KOH was done at room temperature with the help of a hot plate magnetic stirrer (Autoscience AM-5250B, Tianjin Instrument Co.). The amount of KOH and methanol to use for the experiment was calculated according to Gerpen *et al*., 2004. 88.20g (100ml) of *Passiflora edulis* seed oil with a % FFA of 2.41 required 1.25g of KOH while methanol required for the same was 24.65 ml. The KOH crystals were first dissolved in the appropriate amount of methanol and then added to the vegetable oil in a separate conical flask having a magnetic rod placed inside. The flask was then placed in the hot plate and the mixture stirred at a stirring rate of 700rpm for 2 hours. The mixture was then left overnight to settle in a separating funnel .After settling, the mixture separated into two phases, the lower part being glycerin and the upper part the ester layer. The glycerin was then allowed to come out by opening the tap on the separating funnel in order to remain with the ester layer. The ester layer was then transferred to a vacuum rotary evaporator set at 65^0C to remove any excess methanol left. The ester layer was washed by placing it in a separating funnel and spraying warm water (40^oC) representing a quarter amount of the biodiesel being washed using a spraying can and removing the water at the bottom of the funnel. This was done until the wash water did not turn pink on addition of phenolphthalein indicator, indicating that the catalyst was washed out. The ester layer was dried after washing by heating the layer at 60^0C in a beaker until the layer changed from being cloudy to clear indicating that the water had been evaporated. The % yield from the reactions was obtained by dividing the weight of biodiesel obtained with the initial weight of the vegetable oil started with and it was obtained by performing triplicate reactions and obtaining the average. Other parameters measured after obtaining the biodiesel are viscosity, water content, flash point, copper strip corrosion, colour, density and acid value and the results are show in table 1.

3.0 Results

Table 1: Fuel properties measurement

Property	Method	Apparatus	limits	CSEK
Density @ 20^{0}C (kg/m^3)	ISO 12937	S.G density meter (DMA 4500)	860-900	887
Kinematic viscosity at 40^{0}c (mm^2/s)	ISO 3104	Automatic viscometer (HMV 472 HERZOG)	3.5-5.0	4.6
Astm colour	ASTMD 1500	Tintometer (Lovibond PFX880)	Max 3.5	1.6
Copper strip corrosion (3h at 50^{0}c rating, Max)	ISO 2160	Air oven, (Memmert)	Class 1	No tarnish
Density @15 ^{o}C (kg/ m^3)	ISO 12185	Density meter (DMA4500)	860-900	891
Flash point ^{o}C, min	ASTMD 93	Pensky Martens closed cup tester	130 min	>150
Water content % v/v	ASTM D95	Dean and Stark apparatus	0.05	0.09

3.1 Discussion

From the transesterification reaction the yield of biodiesel from *Passiflora edulis* seed oil was 80.37% by weight of the oil. The theoretical value of 100% was not obtained and this can be attributed to saponification where the free fatty acids available in the oil form salts due to reaction with the catalyst. This could have occurred since the oil had a high acid value of 4.82. The results show that the process of transesterification greatly reduces the viscosity which leads to improved fuel properties of the *Passiflora edulis* seed oil. The flash point for the biodiesel which is an indicator of any residual alcohol left in the biodiesel obtained is above 150^{0}C hence it safe to use as there is no risk of explosion .The copper strip corrosion test shows no tarnish on copper hence the fuel is not corrosive to copper and will not corrode engine parts. All the other properties measured which include density (at 20^{o}C and 15 ^{o}C) and ASTM colour meet the given standard apart from the % water content which was 0.09 compared to the maximum water content required which is a maximum of 0.05%.

4.0 Conclusion and Future Perspective

The results show that *Passiflora edulis* seed oil was successfully transesterified using methanol and KOH as a catalyst judging form the viscosity of the biodiesel obtained. Apart from the water content which can be improved by better drying of the biodiesel, all the fuel properties measured were within range according to International Standards Organization (ISO) and the American Society for Testing and Materials (ASTM) standards. The biodiesel obtained from *Passiflora edulis* seed oil can therefore be used as fuel in diesel engines.

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