

Original Research Article

Prospect of biofuel production and its application from plant and animal waste waste byproduct as sustainable energy

Abstract

Biomass derived bio-fuel is biodegradable, nontoxic, sustainable and substitute for fossil fuel as well as capable to reduce greenhouse gas emission like CO₂, CO, SO_x, HC and NO_x. It is renewable and outstanding energy resource for the creation of steam and electricity, transportation fuel, manufacturing industries. Biomass (animal and plants based like, fruits, vegetable, crops, fish, chicken and other animal byproducts or waste biomass) can be used for bioenergy production like biofuel and nanocatalyst for biofuel. Agro waste like animal waste biomass can be the sources of biobiesel, nanocatalysts for bioethanol, bioelectricity) in the agro-industry, pharmaceuticals and biomedical aspect. The energy is an important factor for the development of social and economic of any country. In recent years, using renewable energy as a reducing agent of environmental pollution have become an important issue in the whole world. In this study it is highlighted that biofuel can be produced from camel byproducts or waste like fats, bones, guts etc. Also bioelectricity production can be a great prospect from camel waste derived biofuel using fuel cell. The innovative method and biotechnological approaches can be used in the commercial and industrial purposes in future for vast energy supply.

Keyword: Bioenergy, biofuel, camel waste, bioelectricity

1. INTRODUCTION

The occurrence of oil depletion, global warming and the greenhouse effect has put us on an alarming condition where we need to search for an alternative energy. Hydro, wind, solar, biomass, hydrogen, geothermal, and nuclear energy are the types of natural energy that is readily available and sustainable (Demirbas, 2005).

Among all the renewable energy, biofuel (biodiesel and bioethanol) is one of the most promising energy sources despite diesel-fuel. Biodiesel is the mono-alkyl esters of fatty acids derived from animal fats and vegetable oils. It is produced when vegetable oil or animal fat is reacted chemically with an alcohol to produce fatty acid alkyl esters (transesterification) (Hossain and Boyce, 2009a; Hossain and Boyce, 2009b). Biodiesel have a low emission profile and are environmental friendly, hence not posing dangers to our vulnerable earth. The reason that biodiesel is not utilized widely around the world is due to the high cost of raw materials. To overcome this, it can be a resort to low quality oils for example waste cooking oils and fish fats that are produced in excess in food processing industries. By utilizing these wastes oil could help to overcome the problem of waste oil disposal (Zhang et al., 2003).

The high diesel fuel price today made biodiesel an attractive alternative fuel. Biodiesel has been chosen as one of the main alternative fuel because of its better characteristics and advantages such as: a renewable source, highly biodegradable, high flash point,

excellent lubricity, nontoxic, relatively low amount of polycyclic aromatics hydrocarbons as domestically available. Therefore this environmental friendly biofuel can be utilized in engines without any modification (Hossain and Mazen, 2012). Hossain (2012) reported that bioelectricity can be produced from starch, cellulose and lignocelluloses based vegetable and animal waste and byproducts by fermentation process using different enzyme.

A few of research has been carried out on the production of biodiesel from vegetable oil, animal fats and byproducts as well as fish fats. Therefore, the objectives of this present research is to focus the prospect of the study of biofuel production and its application in engine and bioelectricity generation from animal (camel) waste and byproducts by comparing different animal byproducts like fish, chicken byproducts etc. as renewable energy and to test its characteristics.

2. MATERIALS AND METHODS

2.1 Preparation of oil samples

Waste fish, chicken waste, waste sunflower and palm oil were used in this study to produce biodiesel. Waste sunflower and palm oil were collected from restaurant. Waste fish and chicken fats were collected from the open market where fishes were processed and chicken was slaughtered in Kuala Lumpur, Malaysia. Firstly, the fish and chicken fats were heated to melt it to fish and chicken oil (Figure 1). Secondly filtration was done by utilizing a filter funnel with a piece of filter paper.

2.2 Biodiesel production through transesterification reaction

NaOH (1%) were used as a catalyst to determine its effect on biodiesel yield. The filtered palm, sunflower, fish and chicken oil was preheated in the oven for approximately 15 minute at 60 °C before subjecting it to the transesterification process. When the transesterification process was completed, the solution was separated into two distinct layers of crude biodiesel and glycerol. distinct layers (Figure 1). The methyl esters obtained was washed with distilled water to remove impurities such as pigments, excess alcohol, excess catalysts, glycerol, and soaps. Little quantity of water was eliminated when biodiesel was dried in the oven. The pure and dry biodiesel was produced and used for subsequent gas chromatography-mass spectrometer analysis.

2.3 Camel waste processing for biofuel

Bone and fats were collected from slaughter house. Bone can be crushed or ground by grinder and fats can be heated for oil. Then the same procedure would be followed for oil and for ground bone fermentation process would be followed using amylase and cellulose enzymes.

3. Biodiesel Characterization

The biodiesels have been sent for GC-MS analysis after drying. The main purpose of this analysis was to identify the presence of methyl esters in the produced biodiesel. The higher TAN value (Total acid no.) was determined by titration methods using the ASTM Standard for biodiesel. Viscosity was determined by using viscometer following the ASTM standard for viscosity. Some elemens were dertimined from biofuel following the ASTM standard.

2.5 Engine tests

The biodiesel produced were sent for engine tests to the Tribology Laboratory of the Department of Mechanical Engineering in the Faculty of Engineering, University of

Malaya, An engine test was carried out, which is the emissions test. The model of the single cylinder engine was YANMAR TF120-M..

2.6 Electricity test

This biodiesel and bioethanol (produced from starch based bone powder and cellulose based byproducts from fish, chicken and camel waste after oil extraction) following fermentation process can be used in the fuel cell to produce bioelectricity.

4. RESULTS AND DISCUSSION



Figure. 1. A) Straight sunflower oil, B) Filtered waste sunflower cooking oil, C) Phase separation, upper is biodiesel and D) Formation of emulsion

Table 1: Identification of methyl esters in fish, chickrn, palm and sunflower based biodiesel

Total peak for different samples	Peak serial	RT (min)	Methyl ester	% Relative	Total biodiesel yield
Fish waste	1	12.1	$C_{13}H_{24}O_2 CH_3$	9.9	99.8
	2	16.4	$C_{13}H_{30}O_2 CH_3$	6.8	
	3	20.1	$C_{12}H_{30}O_2 CH_3$	5.6	
	4	20.5	$C_{17}H_{34}O_2 CH_3$	19.7	
	5	23.7	$C_{19}H_{34}O_2 CH_3$	14.2	
	6	23.8	$C_{19}H_{36}O_2 CH_3$	40.6	
	7	24.3	$C_{19}H_{36}O_2 CH_3$	3.0	
Palm oil	1	20.1	$C_{16}H_{29}O_2CH_3$	2.1	98.4
	2	20.5	$C_{16}H_{31}O_2CH_3$	36.1	
	3	23.7	$C_{18}H_{31}O_2CH_3$	11.1	
	4	23.8	$C_{18}H_{33}O_2CH_3$	44.2	
	5	24.3	$C_{18}H_{35}O_2CH_3$	5.1	
Sunflower	1	20.5	$C_{16}H_{31}O_2CH_3$	6.1	98.6
	2	23.7	$C_{18}H_{31}O_2CH_3$	48.2	
	3	23.8	$C_{18}H_{33}O_2CH_3$	42.1	
	4	24.3	$C_{18}H_{35}O_2CH_3$	2.2	

Chicken oil	1	12.2	$C_{13}H_{24}O_2 CH_3$	9.8	99.2
	2	16.0	$C_{13}H_{30}O_2 CH_3$	6.5	
	3	20.2	$C_{12}H_{30}O_2 CH_3$	5.3	
	4	23.6	$C_{19}H_{34}O_2 CH_3$	28.4	
	5	23.1	$C_{19}H_{36}O_2 CH_3$	44.0	
	6	24.2	$C_{13}H_{36}O_2 CH_3$	5.2	
Camel waste	Expected (5 -7 peak)	Expected as chicken	Expected chicken	as Expected as chicken	98- 99 (expected)

It can be seen that there are a total 7, 6, 5 and 4 compounds that are present in the biodiesel sample produced from fish, chicken, palm and sun flower, respectively Table 1). The highest yield of fatty acid methyl esters (FAME) was found in fish oil (99.8%). 2nd highest was found in chicken oil (99.2%).

Table 2: Determination of acid value and viscosity of different waste bio-source biodiesel.

Property	Unit	ASTM value	Fish waste	Chick en waste	Palm waste	Sunfl ower waste	Camel waste
Acid value	mg KHO/g oil	0.50 max	0.42	0.41	0.43	0.44	0.41-0.44 (expected)
Viscosity	mm ² /s at 40 ⁰ C	1.9-6.0	5.4	5.3	4.42	5.7	4.42-5.7 (Expected)

From Table 2, the viscosity of biodiesel produced from transesterification of waste sunflower oil was highest, 5.7 cSt. The kinematic viscosity at 40 ⁰C accepted is limited between 1.9 to 6.0 cSt according to the ASTM. TAN value are followed the ASTM standard.

Table 3. Elements present in different biodiesel compared to ASTM standard

Biodiesel sample	P (PPM)	Ca (PPM)	Mg (PPM)	Na (PPM)	Pb (PPM)	Cu (PPM)
Pure diesel	10	5	5	5	4	4
Fish biodiesel	8	2	3.5	1.5	3.5	3
Palm biodiesel	9	5	5.5	6.0	4	4
Sunflower	9.5	5	5	5.1	4	4
Chicken waste	8.5	2.5	4.0	2.0	3.5	3
Camel waste	-	-	-	-	-	-

The result shown in Table 3 shows that only the all elements value fill within the limits of ASTM D6751 ≤ 5 ppm for Na, Mg, and Ca ≤ 10 ppm for P, Pb ≤ 5 , cu ≤ 5 .

Table 4: Fuel consumption test of different biodiesel

Biodiesel sample	Load	Speed	Fuel consumption (ml/sec)	CO emission (%)	NOx emission (PPM)	HC emission (PPM)
Pure diesel	15 Nm	2000 rpm	0.588	0.030		28
Fish biodiesel	15 Nm	2000 rpm	0.581	0.025		17
Palm biodiesel	15 Nm	2000 rpm	0.613	0.029		25
Sunflower	15 Nm	2000 rpm	0.612	0.028		26
Chicken waste	15 Nm	2000rpm	0.58	0.026		20
Camel waste	-	-	-	-		-

Table 4 shows the specific fuel consumption (SFC) in ml/sec. Fuel consumption, CO, HC and NOx were lower in fish and chicken biodiesel than palm and sunflower. Carbon monoxide concentration from fish oil derived biodiesel was much lower compared to other samples because it possesses a lower acid and viscosity value. The amount of NOx emission is directly related to the exhaust gas temperature and engine combustion chamber temperatures. As the exhaust gas temperature increases, NOx emission also increases. Hence, biodiesel fuelled engines has a higher potential to emit more NOx because the exhaust gas temperature lower as the biodiesel concentration increases (Ramadhas *et al.*, 2005)

3.1 Bioelectricity test

This biofuel (biodiesel and bioethanol produced from starch based bone powder and cellulose based byproducts from fish, chicken and camel waste after oil extraction) following fermentation process can be used in the fuel cell to produce bioelectricity. Hossain (2011) reported that bioelectricity was generated from cellulose, starch and sugar based fruit waste.

5. CONCLUSION

Fish and chicken waste oil showed the higher yield than palm and sunflower biodiesel and the quality of biodiesel produced was the best according to the engine test. Since fish and chicken waste biodiesel showed the good results, it can be expected that camel waste byproducts would be a good source for biodiesel production, less engine emission and can be used as the fuel source in fuel cell for bioelectricity generation.

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