JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PRODUCTION OF BIO-DIESEL FROM WASTE COOKING OIL

[1]Chonde Sachin G., [2]Chonde Sonal G.

[1]Assistant Professor, [2]Assistant Professor

[1]Department of Applied Sciences and Humanities, AMGOI, Vathar, Kolhapur, Mahrashtra, India

Abstract:The aim of the present research study is to produce biodiesel from waste cooking oil (WCO) using Transesterification reaction at laboratory scale and also comparison of the % of yield and quality of Bio-diesel fuel that comply the specification of standard methods (ASTM D 6751 and ISO 3675/p32). For the production of Bio-diesel, WCO is collected from Restaurant, university canteen, snack centre and mixed oil is collected from temple. In transesterification process KOH and NaOH is used as catalyst and Methanol andEthanol were used. All tests are conducted using same volume of alcohol and constant stirring speed i.e., 200 rpm for two hrs, during stirring no heat is supply.

High % yield of Bio-diesel is achieved from WCO collected from Restaurant and snack centre using KOH as a catalyst and methanol. Physico-chemical parameters of both samples are within the prescribed limit of Bio-diesel.

Key Words: Biodiesel production, waste oil, cooking oil etc.

1. Introduction:

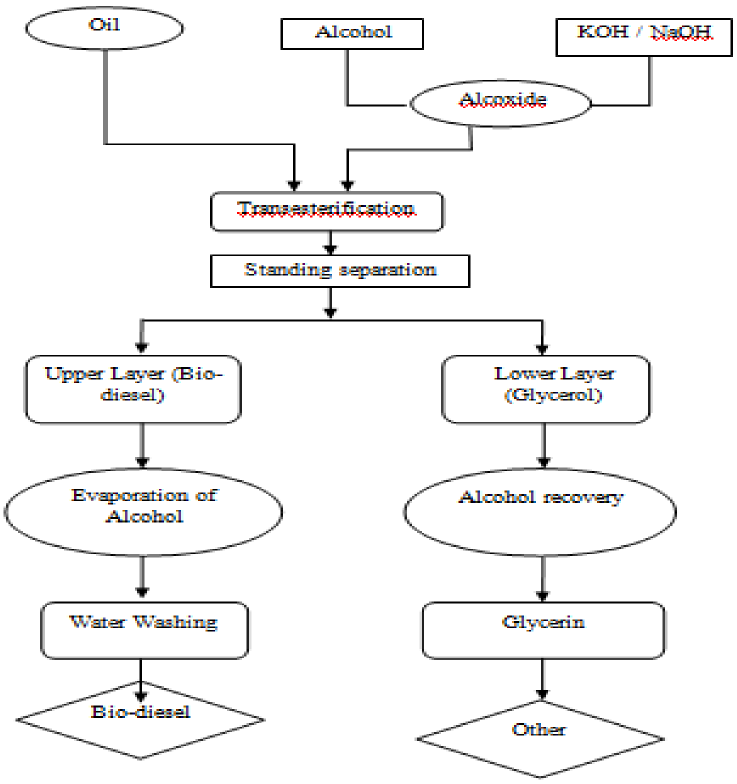
Biodiesel is a source of new renewable energies and a substitute fuel with much potential in the future for petroleum-derived diesel. According to BP Statistical Review of World Energy, total global consumption of diesel from petroleum increasing in one decade which is 3.5 million tonnes in 2010 and 3.9 million tonnes in 2019. Despite reducing the dependence on fossil fuel, the question of how waste cooking oil (WCO) disposal and related environmental damage issues might be solved by biodiesel production. rising petroleum prices, environmental concerns about car exhausts, local changes in the atmosphere, and an increasing proportion in the usage of diesel engines, which have greater performance than gasoline engines, have all led to the growing of biodiesel as a substitute fuel [Yaakob Z 2013]. The use of fossil fuels or petroleum products is becoming more prevalent. According to [Hosseini M. 2012], total global consumption of diesel from petroleum increasing in one decade which is 3.5 million tonnes in 2010 and 3.9 million tonnes in 2019.

Biodiesel is described as an alternative, biodegradable, and renewable diesel fuel [Ayoub M. Z. 2021]. Transesterification of vegetable or animal fats and short-chain alcohols like methanol or ethanol is used to make biodiesel.The advantages of using waste cooking oils to produce biodiesel are low-cost effectiveness and prevention of environmental pollution [Gnanaprakasam A. 2013, Kharina A. 2018]. Generally, if waste oil is disposed of, it has many problems like water and soil pollution, human health concerns, and disturbances to the amphibious ecosystem. Anastasia Kharina et al. [Solikhah M. 2009]

Several studies on biodiesel synthesis from used cooking oil have been carried out. The study [Wang Y. 2007] has synthesized biodiesel from used cooking oil with the trans-esterification process. Research [Carlini M. 2014] has synthesized biodiesel using a two-stage catalyst process, namely the esterification process with ferry sulfate catalyst and potassium hydroxide base catalyst. The biodiesel processing process that uses two stages, namely esterification and transesterification require double consumption of methanol. The addition of catalyst can increase conversion percentage of biodiesel produced [Setiawati E 2012].

2. Materials and Methods:

Flow chart of Production of Bio-diesel



2.1 Filtration and Heating of raw WCO:

During frying food material, there is possibility of presence of small food particles and very minute amount of water molecules in oil. for this reason, the oil sample was filtered and heated at 60^0c for 1 hour to melt coagulated oil and also it allows water molecules to settle down at the bottom of the vessel. Heating of oil reduces the probability of soap formation during the transesterification reaction.

2.2 Free fatty acid test:

This test was analysis for determination of the amount of KOH or NaOH alkali catalyst that must be added to neutralize free fatty acids presents or produced while cooking oil is heated in fryer.

In 100 ml flask 10ml of 91% isopropyl alcohol was added. 1ml of heated oil to the flask containing 91% isopropyl alcohol and stir well for mixing. two drops of phenolphthalein indicator were added. this solution was titrated with 0.1%KOH solution and observed for pink color formation as end point.

2.3 Preparation of Potassium Methoxide:

The 50 ml of methanol was poured in conical flask and seal the lid. KOH was added into the conical flask, secure the lid again and shake it until all the KOH has dissolved. (for 250ml of cooked or waste vegetable oil)

2.4 preparation of crudeBiodiesel: -

Take250ml of preheated, waste cooking oil in beaker andallow it to cool up to 45^0c-50^0c. Once temperature achieved the waste cooking oil was mixed in conical flask containing potassium methoxide solution. Secure the lid. conical flask was shaked continuously at least for 2 hours at 200rpm. After 2 hrs the mixture was transferred to separation funnel. After completion of 24 hrs two separate phases was observed. Upper layer is of crude biodiesel (crude ester) and bottom layer is of glycerol. Bottom layer of glycerol was separated in conical flask and secure the lid (avoid evaporation of alcohol present in it). the upper layer of crude biodiesel was collected in another conical flask.

2.5 Alcohol recovery and purification of separated layer

The Upper layer (crude biodiesel) constitute some impurities, un- reacted alcohol molecules, catalyst or soap. Crude biodiesel was opened for 30 min. and evaporated the excess alcohol. After the evaporation of alcohol, upper layer was washed with warm water. 30% of water per 100 ml of upper layer was added to remove impurities, catalyst or soap. Water was immiscible with bio-diesel; hence it was easily separated from bio-diesel. The procedure was repeated for 2-3 times until the p^H of bio-diesel reaches 7 i.e., neutral. The produced biodiesel was heated at 60^0c about 10-15 min in water bath. The bottom layer (glycerol)constitutes alcohol and soap particles. Alcohol molecules were present in bottom layer which was recovered by using distillation process. Glycerol was purified to about 85% by accumulating with acid (like 85%concentrated phosphoric acid). The acid combines with the residual catalyst to form salt and water. Free fatty acid was recovered and used as boiler fuel or esterifies

2.6 Confirmation test for biodiesel:

Confirmation tests wereperformed to make sure that complete conversion of oil to biodiesel. Theses test was carried out after drying and washing of fuel. The emulsification was completed by one part of biodiesel with water (50/50 mix). The resulting mixture was separated quickly and the biodiesel phase on top was appears clear and bright and the water phase appears at the bottom appears clear and free of debris your fuel is clean.

2.7 The 3/27 Test:

This test works on the basis that biodiesel dissolves in methanol where as triglycerides do not dissolve in methanol. In this process, 3ml of biodiesel was mixed with 27ml of methanol and shaken it for a few seconds.

2.8 Parameter analysis:

a) % of yield:

% of biodiesel yield was analysed to study the quantity of biodiesel was produced from different variety of waste cooking oil.

$$\text{Formula: \% of biodiesel yield} = \frac{\text{Quantity of biodiesel produced}}{\text{Quantity of raw oil taken}} \times 100$$

b) Total Acid Number test (TAN): -

After washing and drying fuel, prior to storage or use and has passes soap titration.This test was run to determine how acidic the biodiesel is after processing.

c) Density:

Density was an important property of Bio-Diesel. Density is nothing but mass per unit volume of any liquid at a given temperature.Density measurements were carried out using density bottle at temperature of 312K.

$$\text{Formula: Density} = \frac{\text{Mass of liquid}}{\text{Volume of liquid}} = \text{gm/cm}^3$$

$$\text{Mass of liquid} = \text{Weight of Density bottle filled with liquid} - \text{weight of empty bottle}$$

d) Viscosity:

Viscosity was measured by using Ostwald's Viscometer

e) Calorific value:

The calorific value of produced biodiesel was measured using bomb calorimeter.

1) Restaurant oil

2) Canteen oil

3) Snack centre

4) Temple oil

Figure -I separation of biodiesel and glycerol (after 24 hrs):

Oil Sample

1^{st} Water washing

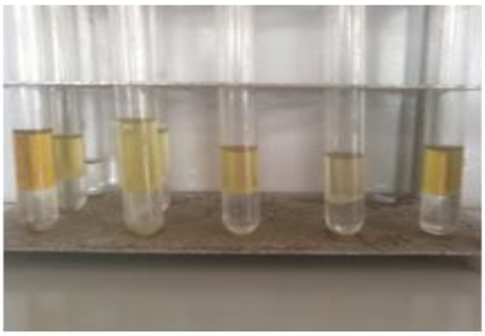
2^{nd} Water washing

3^{rd} Water washing

Figure No 2. water washing of biodiesel sample

Biodiesel sample

Confirmation tests of Bio-Diesel:



Emulsification Phase

β/27 Test

Figure No. 3. biodiesel produced and confirmation test for biodiesel

3. Result and Discussion:

Data representation of Bio-diesel produced from WCO collected from different sites
Contents of Bio-diesel produced from WCO collected from different sites:

Sr. No.	Sample site	Contents Raw oil + Catalyst+ Alcohol
1	Restaurant	250ml oil + 4.5gm KOH +50ml Methanol
2	College Canteen	250ml oil + 4.2gm KOH +Methanol
3	Snack centre	250ml oil + 4gm KOH +Methanol
4	Temple	250ml oil + 3.5gm KOH +Methanol

Table no.1: Study of Free Fatty Acids Present in Waste Cooking oil:

Raw oil sample sites	Free Fatty Acid gm/lit
Restaurant	10
University Canteen	8.8
Snack centre	8
Temple	6

Graph 1: Graphical representation of Free Fatty Acids Present in Waste Cooking oil:

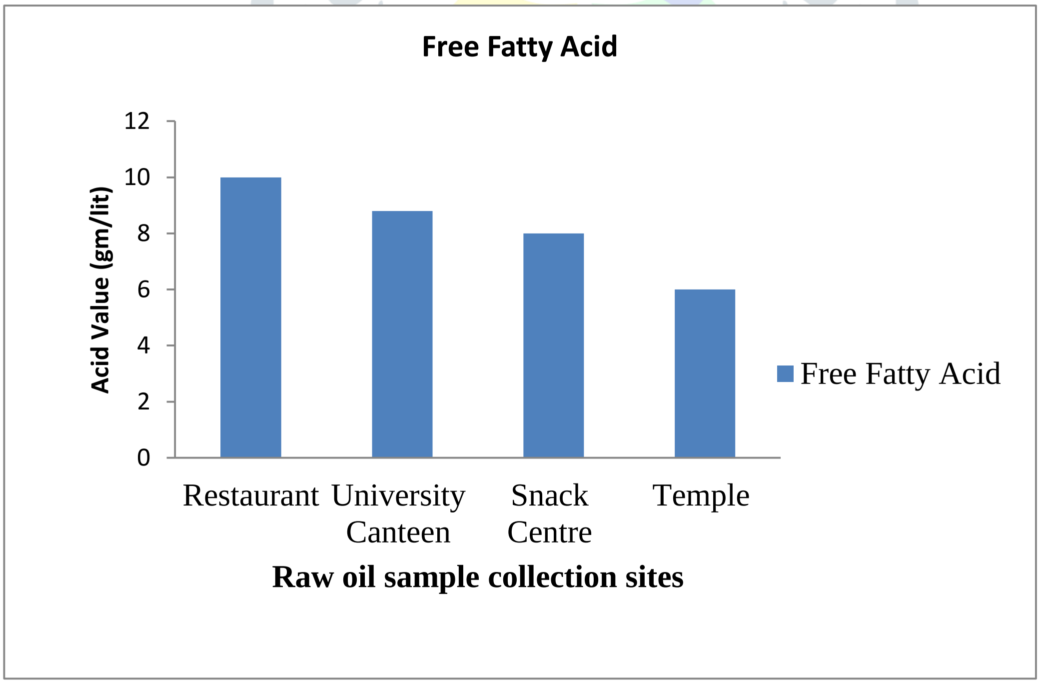


Table no.2: Study of % yield of Bio-Diesel from different oil samples:

Sample sites	% yield
Restaurant	88
University Canteen	84
Snack centre	88
Temple	80

Graph 2: Graphical representation for % yield of bio-diesel from different oil samples:

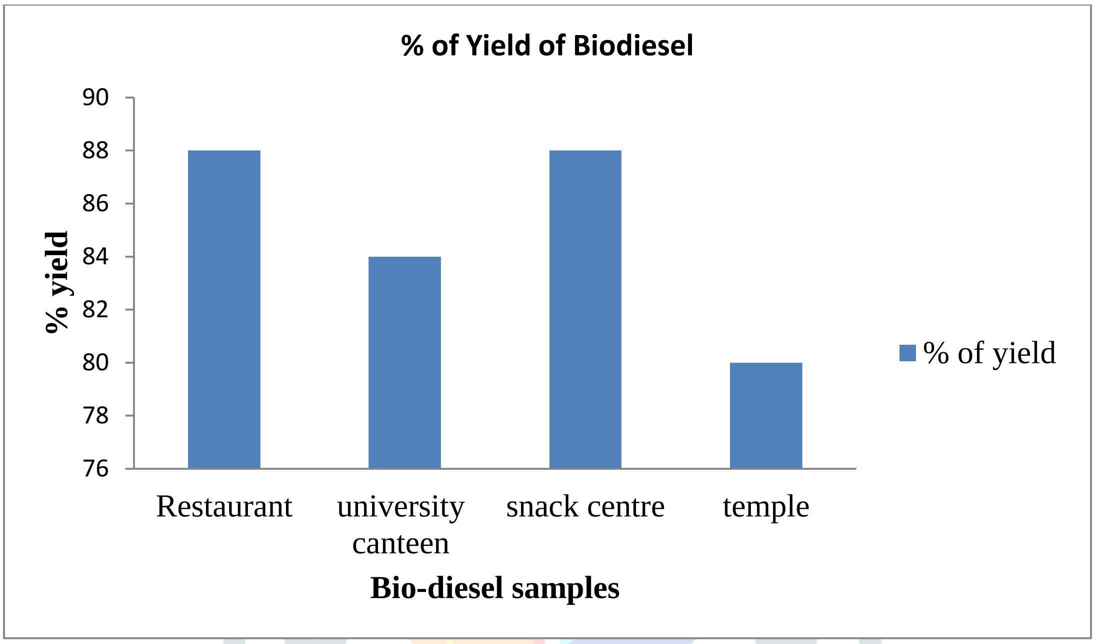


Table 3: Study of Total Acid Number of Bio-Diesel from different oil samples:

Sample sites	Total Acid Number(mg/gm)
Restaurant	0.4824 mg/gm
University Canteen	0.5497 mg/gm
Snack centre	0.4600 mg/gm
Temple	0.4712mg/gm

Graph 3: Graphical representation for Total Acid Number of bio-diesel from different oil samples:

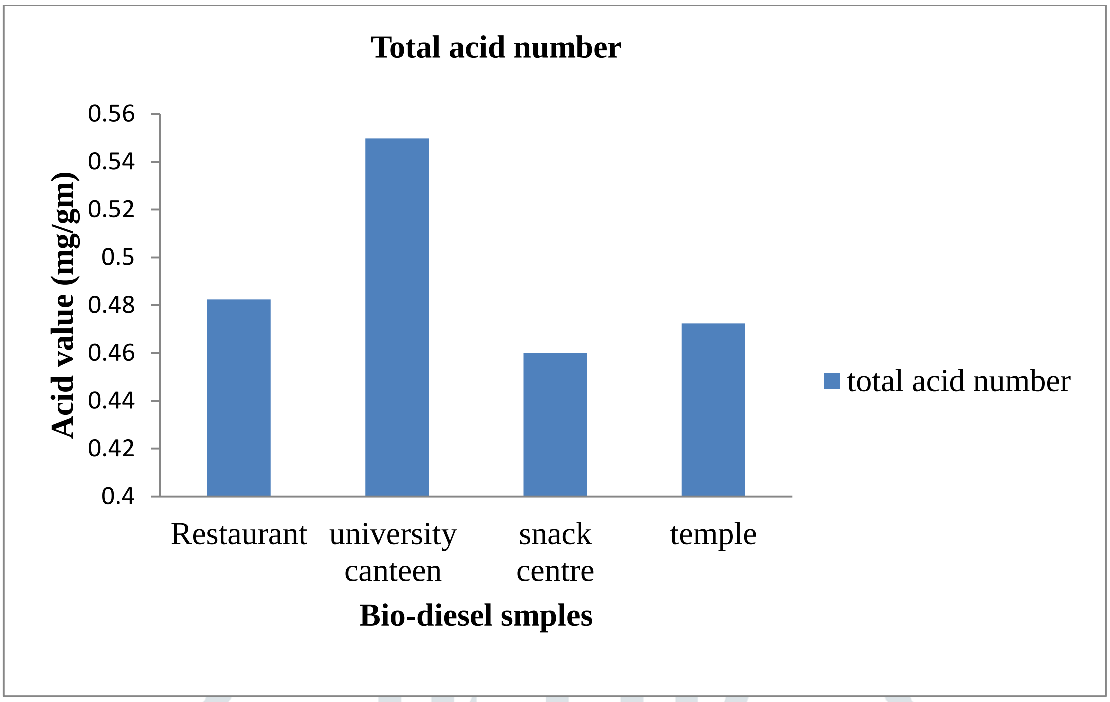


Table 4: Study of Density of Bio-Diesel from different oil samples:

Sample sites	Density gm/cm^3
Restaurant	0.927
University Canteen	0.9369
Snack centre	0.9196
Temple	0.9271

Graph 4: Graphical representation for Density of bio-diesel from different oil samples:

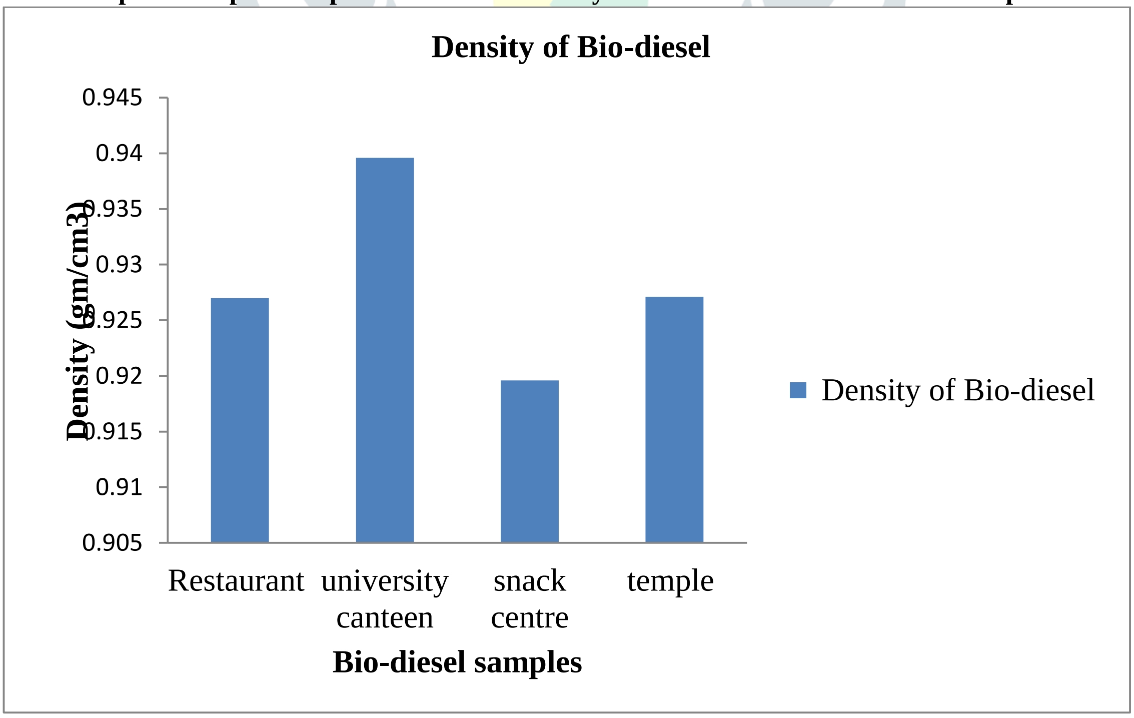


Table 5: Study of Viscosity of Bio-Diesel from different oil samples:

Sample sites	Viscosity of Biodiesel mm^2/s.
Restaurant	6.0369
University Canteen	6.2617
Snack centre	4.7953
Temple	6.0369

Graph 5: Graphical representation for Viscosity of bio-diesel from different oil samples:

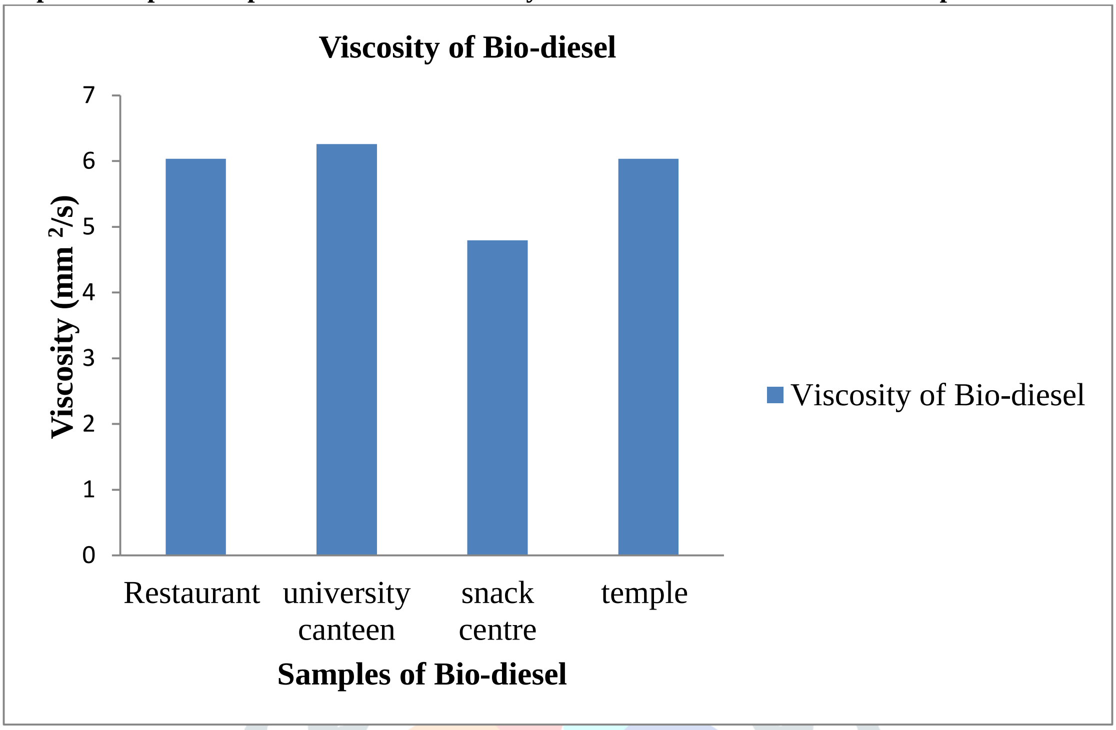
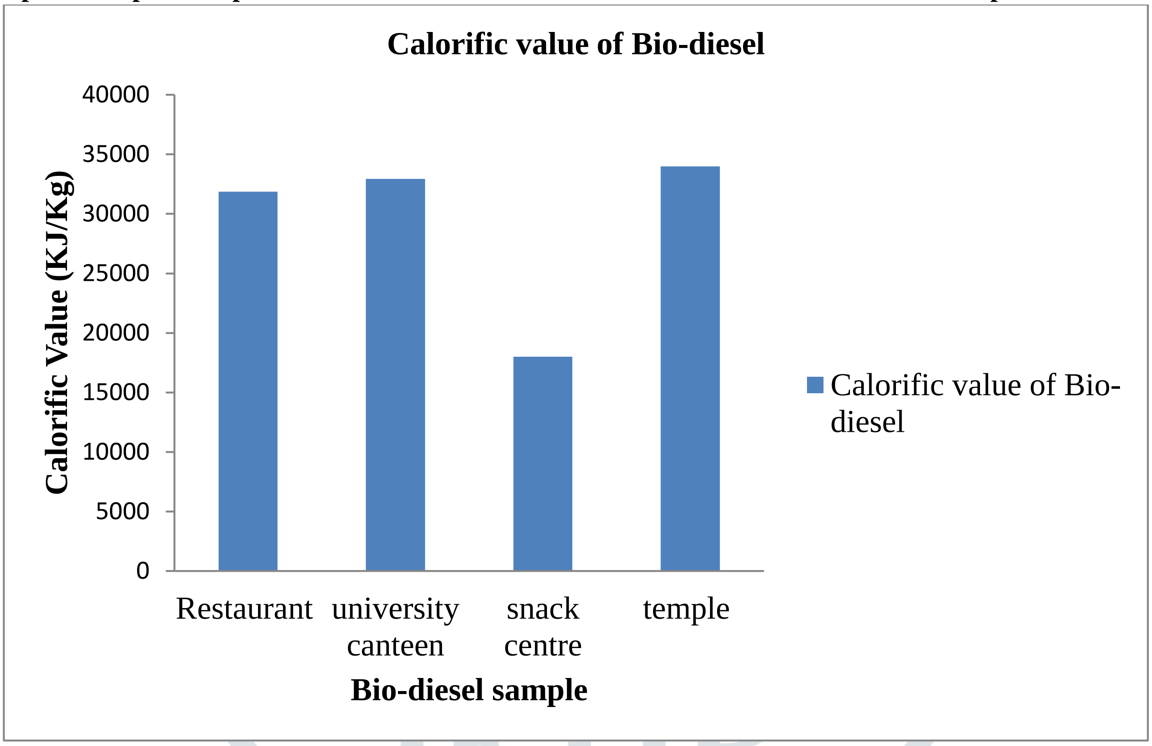


Table 6: Study of Calorific value of Bio-Diesel from different oil samples:

Sample sites	Calorific Value KJ/Kg
Restaurant	31867.490
University Canteen	32934.848
Snack centre	17991.83
Temple	34002.206

Graph 6: Graphical representation for Calorific value of bio-diesel from different oil samples:



4. Conclusion:

From the above study it shows that methanol was the best alcohol for this reaction condition for biodiesel production. the Three-time water washing process was needed to obtain the pure Bio-diesel with close P^H =7. The highest Bio-diesel yield 88% was achieved through trans-esterification of waste cooking oil collected from restaurant and snack centreusing 50ml methanol and KOH as catalyst. It also concludes that the equal amount of catalyst KOH and NaOH was used for same oil sample shows variation in % yield of Bio-diesel due to the different molecular weight of KOH and NaOH, because Free fatty acid test of oil is conducted using 1% KOH. According to this study it is concluded that Waste cooking oil containing high free fatty acid also has potential to provide good quality of Bio-diesel which can be use directly or blending with fuel.

5. References:

1. Ayoub M.Z., M.H.M. Yusoff, M.H. Nazir, I. Zahid, M. Ameen, F. Sher, D. Floresyona, E. Budi Nursanto, A Comprehensive Review on Oil Extraction and Biodiesel Production Technologies. Sustainability, 13, 788, 2021.
2. Carlini M., S. Castellucci, and S. Cocchi, A Pilot-Scale Study of Waste Vegetable Oil Transesterification with Alkaline and Acidic Catalysts, Energy Procedia, vol. 45, pp. 198–206, 2014.
3. Chhetri A.B.,K.W., Islam, M.R., "Waste Cooking Oil as an Alternate Feedstock for Biodiesel Production", Energies, 1996-1073, 2008.
4. Setiawati E.., F. Edwar.," TeknologiPengolahan Biodiesel dariMinyak Goreng Bekas dengan Teknik Mikrofiltrasi dan TransesterifikasisebagaiAlternatif Bahan Bakar Mesin Diesel", Jurnal Riset Industri , Vol.6, No. 2, hal. 117- 127,2012.
5. Encinar, Jose. M., " Preparation and Properties of Biodiesel from Cynara CarduncusL.Oil", Industrial and Engineering Chemistry Research, Vol. 38.,No.8, pp 2927–2931, 1999
6. Gashaw A. and A. Teshita, Production of biodiesel from waste cooking oil and factors affecting its formation : A review, International Journal of Renewable and Sustainable Energy, 3(5): 92-98, 2014.
7. GnanaprakasamA. , V. M. Sivakumar, A. Surendhar, M. Thirumarimurugan, and T. Kannadasan, "Recent Strategy of Biodiesel Production from Waste Cooking Oil and Process Influencing Parameters : A Review, Journal of Energy, vol. 2013.
8. Haryono., C.L.,Natanel, I.,Rahayu, A.N., Wicaksono," Esterifikasi dan TransesterifikasiSerempakMinyakJelantahmenjadi Biodiesel denganKatalis Resin PenukarKation", Prosiding Seminar Nasional MIPA, 2016.
9. Hasanudin, Rachmat, A.," Production of Biodiesel from Esterification of Oil Recovered from Palm Oil Mill Effluent (POME) Sludge using Tungstated-Zirconia Composite Catalyst". Indonesian Journal of Fundamental and Applied Chemistry, Vol. I, No.2, pp. 42-46, 2016.
10. Hosseini M., A.M. Nikbakht, M. Tabatabaei, Biodiesel production in batch tank reactor equipped to helical ribbon-like agitator, Mod. Appl. Sci. 6 (3) (2012) 40–46, https://doi.org/10.5539/mas.v6n3p40.
11. Kharina A., S. Searle, D. Rachmadini, and A. A. Kurniawan, The potential economic, health and greenhouse gas benefits of incorporating used cooking oil into Indonesia's biodiesel, White Pap., no. September, 2018, [Online]. Available: https://theicct.org/sites/default/files/publications/UCO_Biodiesel_Indone sia_20180919.pdf.
12. M.D. Solikhah., Paryanto, I., Barus , B.R., "EfekKualitasMinyakJelantahterhadap Harga Proses Produksi dan Kualitas Biodiesel", Prosiding Seminar Nasional Teknik Kimia IndonesiaSNTKI, Bandung. 2009.
13. Sanli, H., Canakei, M., Alptekin, E, "Characterization of Waste Frying Oils Obtained from Different Fasilities". In Word Renewable Energy Congress, Linkoping,Sweden, 2011
14. Wang. Y., Qou., S.,Liu., P., Zhang, Z.,"Preparation of Biodiesel from Waste Cooking Oil via Two-Step Catalyzed Process, Energy Conversion & Management, Vol.48, Issue 1, pp. 184-188, 2007.
15. Yaakob Z., M. Mohammad, M. Alherbawi, Z. Alam, K. Sopian, Overview of the production of biodiesel from Waste cooking oil, Renew. Sustain. Energy Rev. 18 (2013) 184–193, https://doi.org/10.1016/j.rser.2012.10.016..s