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Trans-Esterification of Poultry Skin Fat to Produce Biodiesel

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Abstract

Chicken skin and its fat are sources of solid waste that are usually not utilized and add solid pollution. This research work deals with the production of useful biodiesel from utilizing the waste chicken (fat and its skins). Waste chicken fat and its skins (sourced from local shops of Hyderabad, Sindh, Pakistan) were extracted and trans-estrification was made. The product of trans-estrification was fatty acid methyl esters (FAME) commonly known as biodiesel. Sodium Hydroxide (NaOH) was used as catalyst and glycerol was obtained as a by-product. The FAME produced was tested for six parameters namely calorific value, cloud point, pour point, flash point, density and viscosity when compared to ASTM E2515-11 standard values. The results of this experiment showed that the calorific value, cloud point, pour point, flash point, density and viscosity values of FAME produced from chicken skin and its fat were close to that of petroleum derived diesel.

Keywords*:* Chicken-Skin, Biodiesel, Poultry waste, Esterification, FAME.

Introduction

In Pakistan 7.2 million tons of furnace oil is consumed per year, whereas the import of diesel and furnace oil is about 9 million tons [1].The Greenhouse gas (GHG) emissions are comparably low in Pakistan contributing 0.43% of the world's total emissions and ranked at 35th in GHG emitting countries list. Alternative energy sources are good options for reducing emissions (Carbon, NOx, SOx), cleaning the air, and more sustainable footing of our civilization. Today, world's attention is focused on a promising alternative fuel.

The biodiesel is best alternate source which produces less hydro carbons, CO, and particulate emissions than regular petroleum diesel [2]. The biodiesel can be produced from straight vegetable oil, animal oil/fats, tallow and waste cooking oil by tranestrification [3,4] and can have the potential to meet the global energy needs growing in sense of overall cost-effectiveness and acceptable fuel properties. Improper disposing creates potentially hazardous solid waste and a serious environmental issue. The poultry skin is an economical source of biodiesel production which not only provides the safe disposal but also makes the environment friendly [5].

The biodiesel production comes from skins, fats of chicken or animals and oil seed plants also the material which contains the triglycerides. Chicken skin is preferable to the edible/non edible oils and waste oils as it contains low or negligible impurities [6]. In 2010 (Fig1 & 2) the larger energy share of world energy consumption is fulfilled by fossil fuels [7, 8].

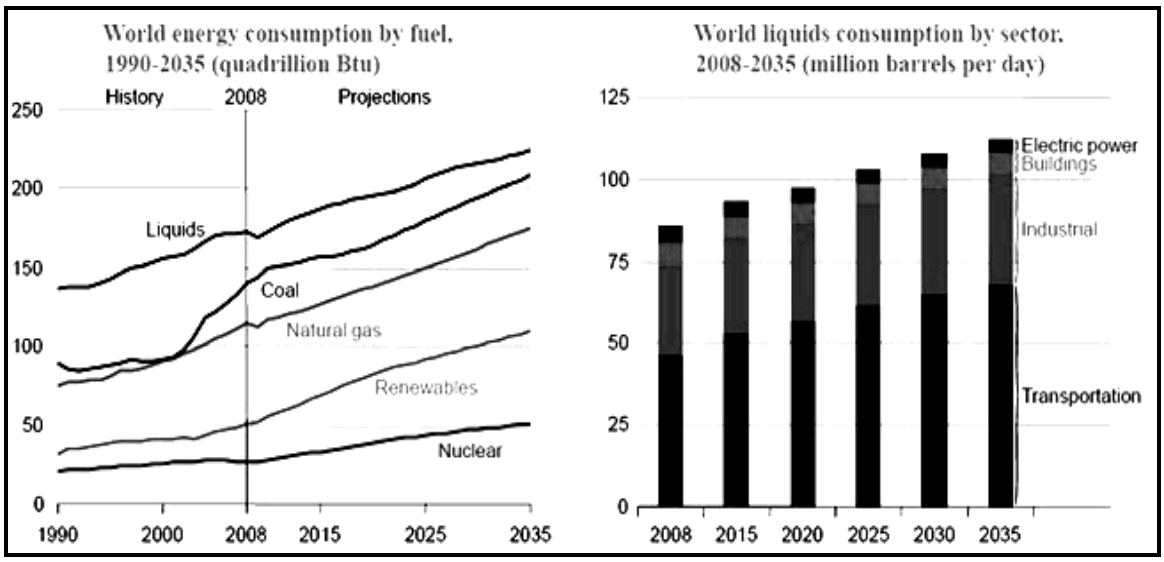

Figure 1. **World energy consumption by fuel, 1990-2035 (Quadrillion Btu)**

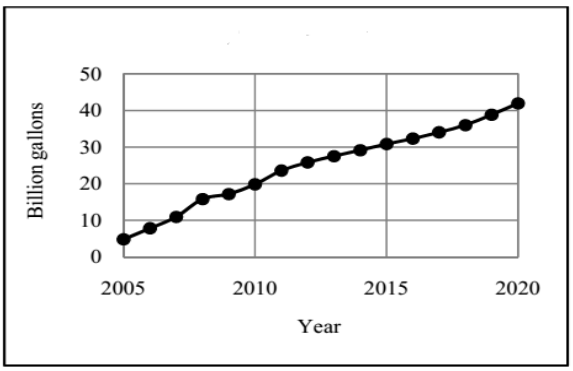

Figure 2. **Estimated production of biodiesel up to 2020**

The biofuels are commonly known as alkyl esters or fatty acid esters. The biofuels can be produced by trasnesterification from oil with base catalyst or acid catalyst. Another method is formation of alkyl esters prior to that the oils will convert into fatty acid using acid catalyst. The bio fuel production with base catalyst is most common, economical and feasible. Because it proceed at comparatively low temperature(150 ^{o}F) and low pressure(20psi) and give high yield around(98%) with low reaction time[11]. Another method is alcohydrolysis referred to multi step trans-estrifiaction reaction carried out in presence of catalyst. The NaOH, KOH or Meth-oxides are the most common catalysts which convert the triglycerides into di-glycerides, monoglycerides and glycerol. The Meth-oxides such as sodium meth oxides gave better yield than NaOH and KOH [12-13].

This study focus the feasibility of biodiesel production from chicken waste in order to meet the energy challenges of the country. The characteristic of prepared biodiesel were also studied.

Materials and Method

The 1kg waste chicken (fats and skins) samples were collected from local chicken stalls of Hyderabad city. It was full of flesh, fat and blood. At first stage was de-feathered and water washed thrice in order to remove all unwanted matters. Then were size into 1-3 cm through knives. Accurately weighted 900g were dip into 1 Liter distilled water and cooked for 9.5 hours and filtered. The filtrate was collected and treated with 250ml NaOH solution (4%) [14-15].The mixture was well shake with alkalis and allowed for settling in separately funnel. It takes around 8 hours when two distinct layers were appeared. Before settling the 10ml chloroform were also added. The yellowish top layer contained biodiesel [16] which were recovered and analyzed.

Figure 3. **Layer of biodiesel produced from chicken-skin**

Results and Discussion

The experimental study showed that around 57.66% biodiesel was obtained and was evaluated by given formula.

$$\text{Biodiesel Obtained (\%)} = \frac{\text{Volume of Biodiesel}}{\text{Amount ofRawmaterial taken}} \times 100$$

The chicken wastes generate per day from Hyderabad shown in table 1. The study reveals that maximum chicken waste was generated from Latifabad Hyderabad this is because of easily accessible [17] to nearby 6 districts. According to theoretical study the Total amount of chicken sell in Hyderabad daily is approximately 40000 kg. Among which the 4000 of biodiesel & 577 of glycerol can be obtained by above mentioned formula.

Table 1. **Results of Survey of Chicken stall in Hyderabad.**

Area in Hyderabad	Chicken Stall	Amount (kg)
Tower Market	Tawakal Chicken House & others	15000-18000
Qasimabad	Qasimabad Chicken House	2000-3000
Latifabad	Pakistan Chicken House	20000-25000

Biodiesel characterization

From Table 2 it has observed that all the values of parameters of biodiesel are compatible with the properties of Petro-diesel as prescribed through American Society of Testing Materials (ASTM) standards [18].

Table 2. **Results of parameters in comparison to ASTM.**

Parameters	Biodiesel	Diesel (Raheman et al; 2007)	ASTM
Calorific Value ($MJKg^{-1}$)	41.5	43.5	42
Density (gcc^{-1})	0.88	0.85	0.87
Kinematic Viscosity (cst)	5.89	2.6	6
Flash Point (^0C)	138	64	165
Cloud Point (^0C)	7	12	9
Pour Point (^0C)	-9	-10	-15

It is observed from Fig. 3 that the density of biodiesel obtained through research is closed to ASTM standardized value and slightly different from diesel value [19].

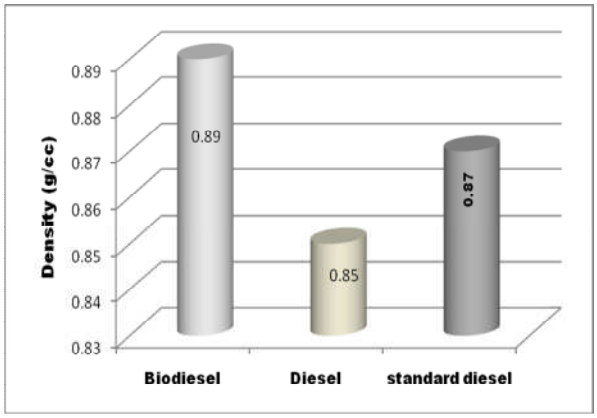

Figure 3. **Comparison of the density of Bio-Diesel with diesel**

Comparing the net calorific value of bio diesel with diesel from (Fig.4) the calorific value of biodiesel is slightly less than the diesel and very close to ASTM standardized value [20].

Calorific value is the amount of heat given out by the sample per unit mass. It suggests that how much efficient the biodiesel fuel is, whether it is suitable for automobile industry or not. The data of above figure shows that the calorific values of commercial biodiesel sample and biodiesel obtained from chicken skin waste were relatively same ($40.2MJkg^{-1}$).

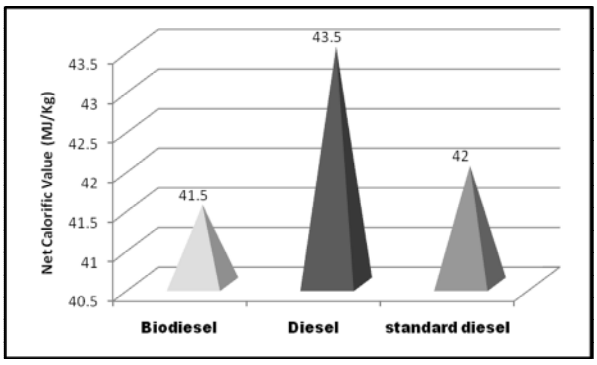

Figure 4. **Comparison of the net calorific values of Bio-Diesel with Dies**

Comparatively high kinematic viscosity was observed in Fig.5 for this product as compared to commercial biodiesel fuel. It shows that there is resistance in the flow of fuel in the internal combustion engine [21].

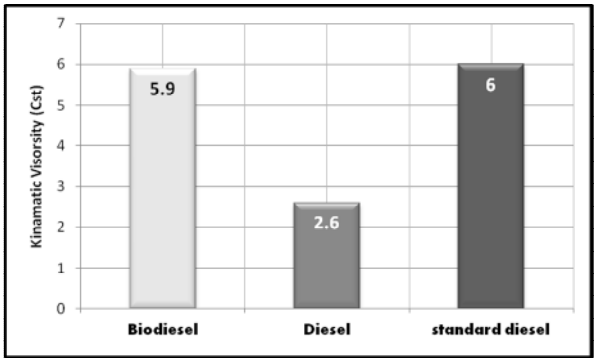

Figure 5. **Comparison of the kinematic viscosities of Bio-Diesel with diesel**

Fig.6 shows that the value of pour point of biodiesel is slightly more than ASTM Value but close to the value of diesel.

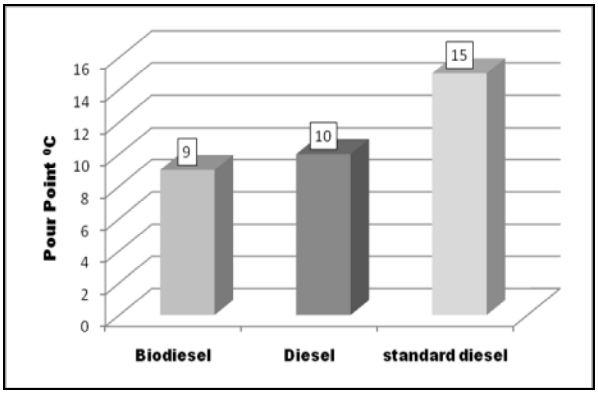

Figure 6. **Comparison of the pour points of bio-diesel with diesel**

Fig. 7 shows that the flash point of biodiesel is more than the diesel and compatible with ASTM value. Flash point is the temperature at which fuel detonate the energy, the energy is sufficient for the internal combustion.

Fig. 8 shows that the cloud point of biodiesel is slightly less than the value of commercial diesel. However it is compatible with ASTM standard value [22].

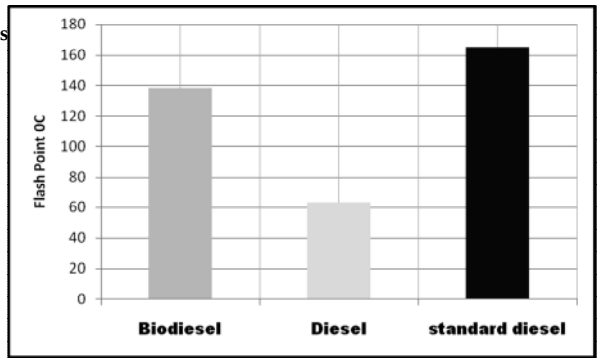

Figure 7. **Comparison of the flash points of bio-diesel with diesel**

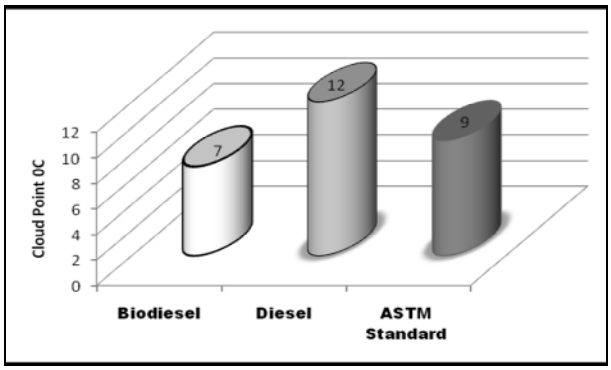

Figure 8. **Comparison of the cloud points of bio-diesel with diesel**

Conclusion

It has concluded that fossil fuels reservoirs are depleting day by day. The biodiesel is best substitute of fossil diesel. It can be produced from various sources including the chicken waste. In Hyderabad Sindh the 40000 kg chicken generated daily. Which can use for biodiesel production be in order to meets energy challenges. The attempted showed that 900gm chicken waste produced 450ml biodiesel using NaOH catalyst. The characteristics of biodiesel were found satisfactory and found

compatible with the international standards set for biodiesel.

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