Data Article

Data on optimization of production parameters on *Persea Americana* (Avocado) plant oil biodiesel yield and quality

Anawe A.L. Paul a,*, Folayan J. Adewale b

a Department of Petroleum Engineering, College of Engineering, Covenant University, Ota, Nigeria
b Department of Petroleum Engineering, University of Ibadan, Nigeria

**Abstract**

Biodiesel has continued to receive enormous patronage from world energy demand as a result of its renewable nature, low toxicity, rapid degradation, robust fuel performance and low emission characteristics and its overall environmental friendliness.

Hence, these data showed the optimization of temperature, catalyst concentration and type of catalyst, alcohol type and alcohol to oil molar ratio and reaction time on Avocado plant oil biodiesel yield and quality produced via alkali-catalyzed transesterification reaction. Data on the quality of the biodiesel produced by using the American Standard for Testing Materials (ASTM) procedures for biodiesel characterization with different concentrations of alcohol and catalyst under varying temperatures and reaction durations are also provided. The tested biodiesel properties are the cold flow properties (pour point and cloud point) and the critical parameters such as kinematic viscosity at 40 °C, specific gravity at 15 °C, flash point, cetane number, calorific value, iodine value, acid number and sulphated ash percentage.

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**Specifications Table**

| Subject area                   | Chemical Engineering                                      |
|--------------------------------|-----------------------------------------------------------|
| More specific subject area     | Bio engineering                                           |
| Type of data                   | Tables, figures                                           |
| How data was acquired          | Experimental. Avocado biodiesel was synthesized in the laboratory by using the following apparatus: measuring cylinder, Erlenmeyer flask, digital weighing balance, magnetic stirrer, electric oven and separating funnel. The biodiesel qualities were evaluated by using the American Standard for Testing Materials (ASTM) procedures. |
| Data format                    | Raw, Analyzed                                             |
| Experimental factors           | Biodiesel yield and quality from transesterification reaction is dependent on a lot of factors. These are reaction time, type of alcohol and alcohol to oil molar ratio, reaction temperature and pressure, concentration and type of catalyst, water content and free fatty acid level in fats and oils. |
| Experimental features          | The Avocado biodiesel was produced in the laboratory by the reaction of a known quantity (1000 ml and 600 ml) of Avocado Oil with selected alcohols (Methanol and Ethanol) at various Alcohol to Oil molar ratios under different operating conditions of temperature and catalyst concentration (NaOH and KOH catalyst) in a process known as trans-esterification reaction. |
| Data source location           | Research Laboratory, PTI, Nigeria.                        |
| Data accessibility             | Data are available within this article                    |
| Related Research Article       | None                                                      |

**Value of the data**

- The data showed the technical viability and environmental friendliness potential of Avocado Oil as a new discovery and promising candidate in the endless search for biodiesel fuel.
- The data will provide useful information to the scientific community on the effect of various production parameters on Avocado (*Persea Americana*) plant oil in biodiesel yield and quality produced via alkali catalyzed transesterification reaction.
- The data describes the optimum conditions under which biodiesel production from Avocado Oil can be termed efficient and thereby reducing cost of production and waste.
- The data analyzed and compared the quality of biodiesel obtained by varying degree of alcohol and type of alcohol as well as catalyst concentration and type of catalyst by using American Society for Testing Materials (ASTM) standard procedures and techniques.
- The data will serve as guide to various bio-energy operators on the consequence of increasing and reducing one parameter or the other on biodiesel cold flow properties and critical parameters.

1. Data

The data obtained from this research work come from the experimental investigation of the effect of temperature, catalyst concentration and type of catalyst, alcohol type and alcohol to oil molar ratio and reaction time on Avocado plant oil biodiesel yield and quality produced via alkali catalyzed transesterification reaction. These parameters were varied at reasonable ratios and concentrations and the emerging result on biodiesel yield and quality were measured. Table 1 and Fig. 2 showed the effect of temperature on Avocado plant oil biodiesel yield production by using Avocado Oil volume of 1000 ml, Methanol to Oil molar ratio of 6:1 and NaOH catalyst concentration of 1%w/w and reaction time of two hours (2 h). Table 2 and Fig. 3 described the effect of type of alcohol and alcohol to oil
### Table 1
Effect of temperature variation on Avocado biodiesel yield.

| Experiment run | Temperature (°C) | Biodiesel produced (ml) | Biodiesel yield (%) |
|----------------|------------------|-------------------------|---------------------|
| 1              | 25               | 482                     | 48.20               |
| 2              | 30               | 516                     | 51.60               |
| 3              | 35               | 550                     | 55.50               |
| 4              | 40               | 621                     | 62.10               |
| 5              | 45               | 718                     | 71.80               |
| 6              | 50               | 792                     | 79.20               |
| 7              | 55               | 886                     | 88.60               |
| 8              | 60               | 945                     | 94.50               |
| 9              | 65               | 962                     | 96.20               |
| 10             | 70               | 720                     | 72.00               |

**Fig. 1.** Flow chart for biodiesel production from Avocado plant Oil with < 2.50% Free Fatty Acid.
molar ratio on biodiesel yield produced by reacting 600 ml of Avocado Oil with different concentrations of methanol and ethanol in the presence of 1%w/w concentration of sodium hydroxide catalyst and reaction temperature of 65 °C for two hours. The data on the effect of catalysts type and reaction temperature on Avocado biodiesel yield.

**Table 2**

| Experimental run | Alcohol: oil | Methanol biodiesel produced(ml) | Ethanol biodiesel produced(ml) | Methanol biodiesel yield(%) | Ethanol biodiesel yield(%) |
|------------------|-------------|---------------------------------|-------------------------------|-----------------------------|----------------------------|
| 1                | 1:1         | 219                             | 190                           | 36.50                       | 31.67                      |
| 2                | 2:1         | 271                             | 225                           | 45.15                       | 37.50                      |
| 3                | 3:1         | 350                             | 314                           | 58.33                       | 52.33                      |
| 4                | 4:1         | 404                             | 357                           | 67.33                       | 59.50                      |
| 5                | 5:1         | 513                             | 385                           | 85.50                       | 64.17                      |
| 6                | 6:1         | 579                             | 428                           | 96.50                       | 71.33                      |
| 7                | 7:1         | 519                             | 493                           | 86.50                       | 82.17                      |
| 8                | 8:1         | 488                             | 532                           | 81.33                       | 88.67                      |
| 9                | 9:1         | 447                             | 557                           | 74.50                       | 92.83                      |
| 10               | 10:1        | 410                             | 550                           | 68.33                       | 91.67                      |
| 11               | 11:1        | 369                             | 507                           | 61.50                       | 84.50                      |
| 12               | 12:1        | 315                             | 460                           | 52.50                       | 76.67                      |

**Fig. 2.** Effect of temperature variation on Avocado biodiesel yield.

**Fig. 3.** Effect of type of alcohol and alcohol to oil molar ratio on Avocado biodiesel yield.
Table 3
Effect of catalyst concentration and type of catalyst on Avocado biodiesel yield.

| Experimental run | Catalyst concentration (%w/w) | Biodiesel produced (ml) (NaOH catalyst) | Biodiesel produced (ml) (KOH catalyst) | Biodiesel yield (%) (NaOH catalyst) | Biodiesel yield (%) (KOH catalyst) |
|------------------|-------------------------------|----------------------------------------|----------------------------------------|------------------------------------|------------------------------------|
| 1                | 0.25                          | 341                                    | 286                                    | 34.10                              | 28.60                              |
| 2                | 0.50                          | 565                                    | 484                                    | 56.50                              | 48.40                              |
| 3                | 0.75                          | 865                                    | 691                                    | 86.50                              | 61.30                              |
| 4                | 1.00                          | 941                                    | 766                                    | 94.10                              | 76.60                              |
| 5                | 1.25                          | 845                                    | 883                                    | 84.50                              | 88.30                              |
| 6                | 1.50                          | 755                                    | 954                                    | 75.50                              | 95.40                              |
| 7                | 1.75                          | 630                                    | 911                                    | 63                                 | 91.10                              |
| 8                | 2.00                          | 516                                    | 788                                    | 51.60                              | 78.80                              |
concentration are presented in Table 3 and Fig. 4. The analyzed biodiesel was produced by reacting 1000 ml of Avocado Oil with NaOH and KOH catalysts at different concentrations. The catalysts were firstly dissolved in methanol to form Alkoxides and methanol to oil molar ratio of 6:1 was used while the transesterification reaction was carried out at temperature of 65 °C and reaction time of two hours. Similarly, Table 4 and Fig. 5 represent the effect of different reaction durations on biodiesel

| Experimental run | Reaction time (min) | Methanol biodiesel produced (ml) | Ethanol biodiesel produced (ml) | Methanol biodiesel yield (%) | Ethanol biodiesel yield (%) |
|------------------|---------------------|---------------------------------|--------------------------------|------------------------------|----------------------------|
| 1                | 15                  | 231                             | 214                            | 38.50                        | 35.67                      |
| 2                | 30                  | 338                             | 306                            | 56.33                        | 51                         |
| 3                | 45                  | 411                             | 379                            | 68.50                        | 63.17                      |
| 4                | 60                  | 526                             | 471                            | 87.67                        | 78.50                      |
| 5                | 75                  | 553                             | 518                            | 92.17                        | 86.33                      |
| 6                | 90                  | 567                             | 549                            | 94.50                        | 91.50                      |
| 7                | 105                 | 576                             | 554                            | 96                           | 92.33                      |
| 8                | 120                 | 580                             | 562                            | 96.67                        | 93.67                      |

Fig. 4. Variation of catalyst concentration and type of catalyst on Avocado biodiesel yield.

Fig. 5. Effect of reaction time variation on Avocado biodiesel yield.
yield by the transesterification of 600 ml of Avocado Oil in the presence of sodium hydroxide catalyst (1% w/w NaOH). The reaction temperature was 65 °C and alcohol to oil molar ratio of 6:1 and 9:1 was used for methanol and ethanol respectively.

Finally, the effects of various parameters and reagents on Avocado biodiesel qualities are presented in Tables 5–8. The importance of repeatability in data accuracy and precision was considered during the course of the experiment.

**Table 5**
Avocado biodiesel quality characteristics at 1% w/w NaOH, 65 °C reaction temperature, 2 h reaction time and Methanol to Oil ratio of 6:1.

| Test property                  | Test method | Test result | ASTM standard      |
|-------------------------------|-------------|-------------|-------------------|
| Kinematic viscosity @ 40 °C   | ASTM D445   | 3.75        | 1.9–6.0           |
| Specific Gravity @ 15 °C      | ASTM D1298  | 0.875       | 0.86–0.90         |
| Flash Point (°C)              | ASTM D93    | 148         | 130 min.          |
| Pour Point (°C)               | ASTM D5853  | –6          | –10 max.          |
| Cloud Point (°C)              | ASTM D2500  | 4           | Report            |
| Cetane Number                 | ASTM D613   | 55.10       | 47 min.           |
| Calorific Value (kJ/kg)       | ASTM D240   | 40.106      | Sufficiently close to diesel |
| Iodine Value ($\text{g I}_2/\text{100 g of biodiesel}$) | ASTM D445 | 78     | Report            |
| Acid Number ($\text{mg KOH} / \text{g}$) | ASTM D664 | 0.35     | 0.8 max          |
| Sulphated Ash (%)             | ASTM D874   | 0.016       | 0.02 max.         |

**Table 6**
Avocado biodiesel quality characteristics at 1% w/w NaOH, 65 °C temperature, 2 hrs reaction time and Ethanol to Oil ratio of 9:1.

| Test property                  | Test method | Test result | ASTM standard      |
|-------------------------------|-------------|-------------|-------------------|
| Kinematic viscosity @ 40 °C   | ASTM D445   | 4.60        | 1.9–6.0           |
| Specific Gravity @ 15 °C      | ASTM D1298  | 0.894       | 0.86–0.90         |
| Flash Point (°C)              | ASTM D93    | 162         | 130 min.          |
| Pour Point (°C)               | ASTM D5853  | –12         | –10 max.          |
| Cloud Point (°C)              | ASTM D2500  | –2          | Report            |
| Cetane Number                 | ASTM D613   | 56.80       | 47 min.           |
| Calorific Value (kJ/kg)       | ASTM D240   | 40.365      | Sufficiently close to diesel |
| Iodine Value ($\text{g I}_2/\text{100 g of biodiesel}$) | ASTM D445 | 74     | Report            |
| Acid Number ($\text{mg KOH} / \text{g}$) | ASTM D664 | 0.30     | 0.80 max          |
| Sulphated Ash (%)             | ASTM D874   | 0.018       | max.              |

**Table 7**
Avocado biodiesel quality characteristics at different NaOH catalyst concentrations using Ethanol to oil ratio of 9:1, temperature of 65 °C and 2 h reaction time.

| Test property                  | 0.25% NaOH | 0.50% NaOH | 0.75% NaOH | 1.00% NaOH | 1.25% NaOH | 1.50% NaOH |
|-------------------------------|------------|------------|------------|------------|------------|------------|
| Kinematic viscosity@ (mm²/s)  | 9.80       | 8.36       | 6.94       | 4.60       | 4.78       | 5.86       |
| Specific Gravity @ 15 °C      | 0.908      | 0.898      | 0.891      | 0.894      | 0.896      | 0.905      |
| Flash Point (°C)              | 186        | 174        | 166        | 162        | 146        | 131        |
| Pour Point (°C)               | 3          | –1         | –6         | –12        | 2          | 4          |
| Cloud Point (°C)              | 9          | 5          | 1          | –2         | 3          | 6          |
| Cetane Number                 | 48.60      | 51.50      | 54.40      | 56.80      | 53.60      | 49.50      |
| Calorific Value (kJ/kg)       | 39.864     | 40.110     | 40.218     | 40.365     | 40.146     | 40.020     |
| Iodine Value ($\text{g I}_2/\text{100 g of biodiesel}$) | 88         | 85         | 81         | 74         | 76         | 83         |
| Acid Number ($\text{mg KOH} / \text{g}$) | 0.84       | 0.73       | 0.55       | 0.30       | 0.34       | 0.30       |
| Sulphated Ash (%)             | 0.048      | 0.031      | 0.024      | 0.018      | 0.021      | 0.021      |
2. Experimental design, materials and methods

The Avocado biodiesel was produced in the laboratory by a process known as transesterification [1–7] and the reaction is a six staged process of oil heating, formation of alkoxide, transesterification reaction, products separation, crude biodiesel purification and methanol recovery. The process flow chart is shown in Fig. 1. The process involves the reaction of a known quantity (1000 ml and 600 ml) of Avocado Oil with selected alcohols (Methanol and Ethanol) at various Alcohol to Oil molar ratios under different operating conditions of temperature and catalyst concentrations (NaOH and KOH catalyst). The reaction mechanism has three main steps as shown in Eqs. (1)–(3). The first step involves an attack by the alkoxyde ion, to form a tetrahedral intermediate. The second step involves the generation of alkoxyde by the reaction between the intermediate produced in the first step with an alcohol molecule. While in the last step, ester and diglycerides are produced with the liberation of three ester molecules(biodiesel) and glycerol (propane 1,2,3 triol).

Reaction mechanism

\[
\text{Step1 Triglycerides} + CH_3OH_{\text{catalyst}} \xrightarrow{\text{Temperature}} Di - \text{glycerides} + \text{Methylester} \\
\text{Step2 Di} - \text{glycerides} + CH_3OH_{\text{catalyst}} \xrightarrow{\text{Temperature}} \text{Monoglycerides} + \text{Methylester} \\
\text{Step3 Monoglycerides} + CH_3OH_{\text{catalyst}} \xrightarrow{\text{Temperature}} \text{Methylester} + \text{Glycerol}
\]

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Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2018.08.064.
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