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# Production of Biodiesel and Minerals from Palm Kernel Oil Using Calcium Oxide Nano-Catalyst from Various Shells

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## Abstract:

Biodiesel production from clean energy sources has significantly gotten attraction because of its prospective as a green and ecologically sound alternative to conventional fossil fuels. In this research, correlative manufacturing of biodiesel from palm kernel oil employing calcium-oxide-nano-catalyst from duck fowl, native fowl and snail egg shells were studied at temperature of $100^{O}$ C in other to produce different yields of biodiesel. The experimental process involved trans-esterification of the extracted palm kernel oil using the prepared nano-catalysts obtained by grinding and heating of shells in a furnace at a temperature of 900 degree Celsius for three hours. The samples were characterized for X-ray diffraction analysis and X-ray fluorescence as well as Transmission electron microscopy. The procedure and results in the process exhibited different phase names such as silicon oxide, hanksite, chaoite etc. Essentially, the X-ray diffraction analysis for native fowl/broiler/A1 eggshells showed a peak of 24.5 at 2Θ, with an intensity of 500 cps in the phase data view for mainly silicon oxide and hanksite while duck fowl eggshells/ A2 maintained an intensity of 600 cps at a peak of 23.415 at 2Θ for $SiO_2$, M03 ·6 $H_2O$, similarly A3/snail eggshells gave a peak of 23.863 at 2Θ with an intensity of 600 cp experimentation for A1, A2 and A3 produced various minerals, allotrope of carbon and nano graphite as well as other synthetic materials. From the results, it was discovered that the eggshells of native fowl/broiler and duck fowl contains the highest composition of Calcium oxide and silicon oxide whereas duck fowl eggshells moreover gave the highest yield of biodiesel.

*Keywords* — **Esterification, calcium oxide, emission, fossil fuel, characterization, nano-catalyst**

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## I. INTRODUCTION

The global demand for energy such as premium motor spirit has resulted in massive environmental degradation and pollution with effects of respiratory diseases and cancer due to the destruction of the eco-system. Consequently, oil exploration and release of nursery gases, trace gases as well as the depletion of petroleum reserves and ozone layer causes global warming, climate change, ocean surge and biodiversity loss. This challenge has endeared researchers to search for renewable energy that could help protect the environment.

Alternative energy such as solar, wind and biodiesels are perfect options instead of petroleum-based fuels. Fossil fuel usage and the adverse environmental effect coupled with high cost of crude oil due to the removal of petrol subsidy in Nigeria has necessitated the need for the production of bioenergy to provide not only cheaper energy but also cleaner power to protect organisms. (ClientEarth, 2022).

Biodiesel is a biodegradable, renewable energy produced from vegetable oils and fats as well as eggshells from animals. It is a harmless fuel with minimum particulate and volatile flammable

  

hydrocarbons as well as low carbon discharge, and maximum combustion fuel efficiency with high octane number and flash point. Objectives of the study are:

- Preparation of the nano catalyst from the egg shells of duck and native fowl and snail shells.
- Trans esterification of the acquired palm kernel oil
- Characterization for X-ray diffraction , X-ray fluorescence and Transmission electron microscopy

## II. RELATED LITERATURES

Economic potentials of bio-fuel manufacturing has been determined using modelling structures through combination of theory and empirical models which involved separation from incidental land use modifications due to land contentions with other functions (R. Sigamoney,H. Von Blottnitz, 2019). (Ponte, 2014) has conducted similar studies with the objective of providing important tips to fasten growth of innovative and emerging technologies for commercialization of bio fuel production that is micro-algae based. Other preliminary works by (Tamerat Demeke Agonfer, 2022) involved comparative use of organic waste for bio fuel production through combination of different theories and methods which is geared towards the green criteria by production and commercializing different yields of biodiesel for clean energy attainment.

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## III. MATERIALS AND METHODOLOGY

The materials and equipment used for this research work are; snail eggshells , duck fowl, and native/broiler fowl eggshells, and palm kernel oil, others are methanol (CH3OH), ethanol ($C_2H_5OH$), beaker, conical flask, measuring cylinder, magnetic stirrer, weighing balance, electric heater, oven, thermometer, separating funnel. Others are Mortar and Pestle, Thermometer, Tube furnace, Vacuum dryer, Incubator etc.

The method involves obtaining eggshells from the poultry farm, and thereafter boiling the eggs so as to remove the membrane before the process of calcination. The shells were furthermore grinded to achieve a better surface area for esterification. In addition, the heated shells literally forms nano-calcium oxide particles obtained at a furnace temperature of 900 degree Celsius for three hours.

Overall, biodiesel and various minerals were produced by specifically adding four grams of the nano catalyst to ethanol, agitated in a magnetic stirrer at a temperature of 90 degrees Celsius for ten minutes, and filtered for characterization.

- Calculation of biodiesel yield

$$\text{Biodiesel yield} = \frac{Volume\ of\ Biodiesel}{Volume\ of\ palm\ kernel\ \ oil} \quad (1)$$

- Calculation of Density

$$\text{Density} = \frac{mass}{Volume} = \frac{15.48}{13.02} = 1.189 \text{ at } 60^0\text{C}$$

## IV. RESULTS AND DISCUSSIONS

The biodiesel samples during the experimentation were identified as A1, A2 and A3, containing extracts of combination from various egg shells gotten from native/broiler and duck fowl egg shells as well as snail egg shells. In addition, the fractionate were packaged after the experimentation, and sent to the laboratory for characterization which is basically testing of the physical properties and analysis of the materials' interior structure using Transmission electron microscopy, X-ray diffraction and X-ray fluorescence techniques.

The procedure and results in the process exhibited different phase names such as silicon oxide, hanksite, chaoite etc. Essentially, the X-ray diffraction analysis for native fowl/broiler/A1 eggshells showed a peak of 24.5 at 2Θ, with an intensity of 500 cps in the phase data view for mainly silicon oxide and hanksite while duck fowl eggshells/ A2 maintained an intensity of 600 cps at a peak of 23.415 at 2Θ for $SiO_2$, M03 ·6 $H_2O$, similarly A3/snail eggshells gave a peak of 23.863 at 2Θ with

  

an intensity of 600 cps and are presented in Figures 1, 2, and 3 in the X-ray diffraction plots.

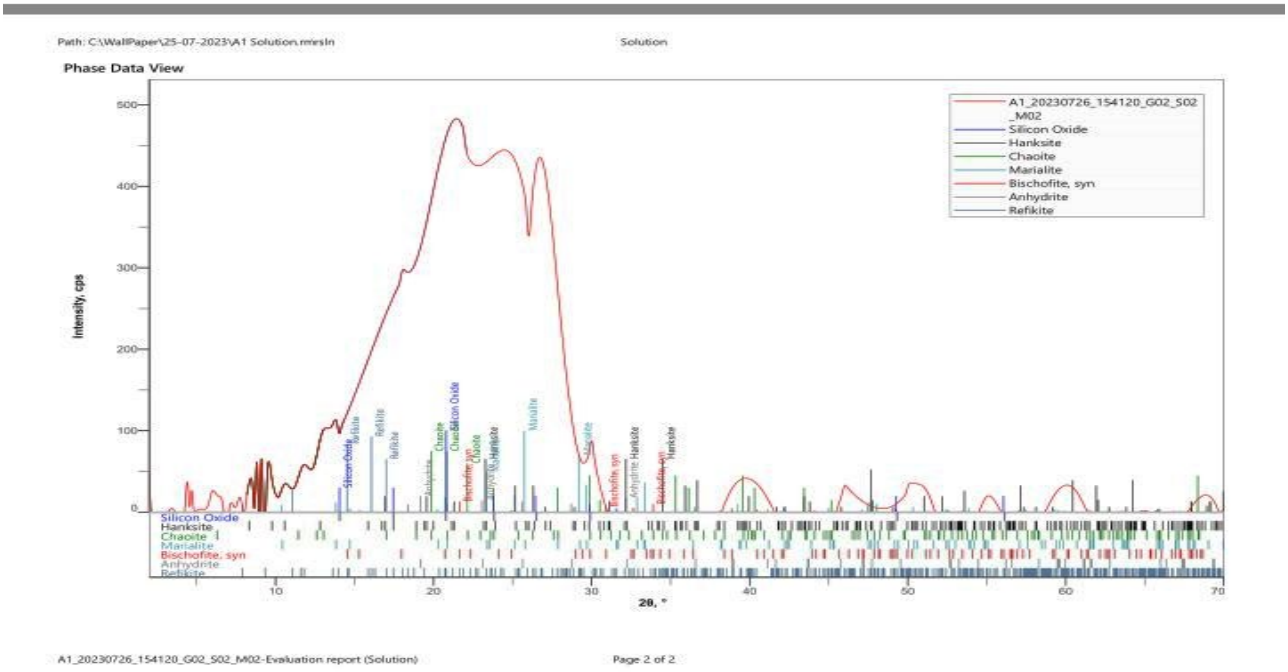


Fig. 1: Xrd Analysis for Native/Broiler Fowl E Shell Sample A1

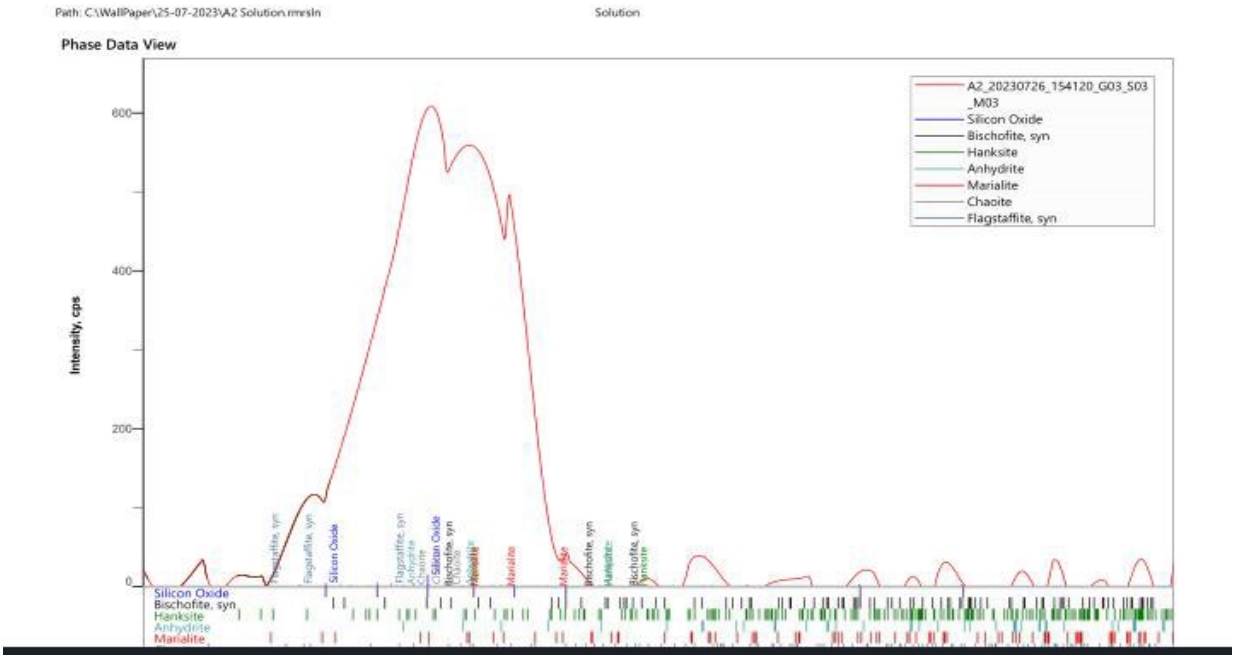


Fig. 2: Xrd Analysis for Duck Fowl Egg Shell Sample A2

  

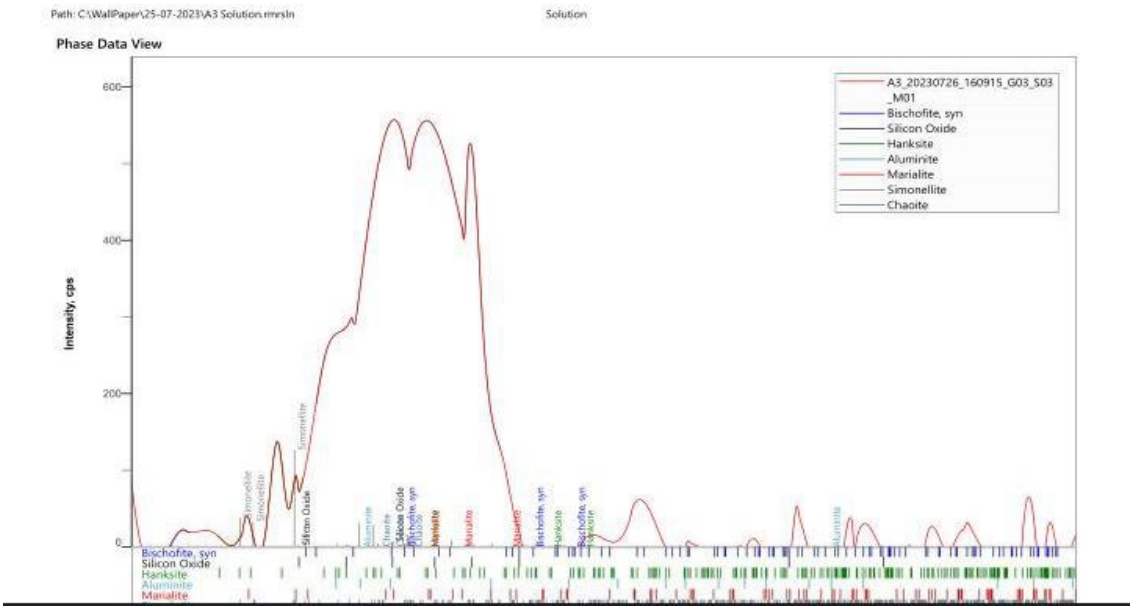


Fig. 3: Xrd Analysis for Snail Egg Shell Sample A3

From the quantitative analysis report, it was discovered that the compounds produced during the experimentation for A1, A2 and A3 produced various minerals, allotrope of carbon and nano graphite as well as other synthetic materials. Hence, besides the produced biodiesel, other minerals in the plot of results/pie chart displayed many useful applications ranging from construction to agriculture as well as medical and chemical industrial significance. Similarly, Figure 4 depicts the phase names and percentages of the x-ray diffraction report and is presented in Table 1

Table 1: Xray Diffraction Report

| NAME PHASE | A1/ Native Fowl (%) | A2/Duck Fowl (%) | A3 /Snail Shell (%) |
|---|---|---|---|
| Silicon | 40 (2) | 44.1 (5) | 9.17 (3) |
| Thanksite | 23 (4) | 0.1 (4) | 24.82 (6) |
| Chaoite | 20 (2) | 0.3 (8) | 0.02 (5) |
| Marialite | 13 (2) | 0.1 (2) | 0.001 (2) |
| Bischofite,syn | 1.1 (8) | 28.3 (3) | 39.20 (8) |
| Anhydrite | 1.2 (6) | 26.5 (3) | |
| Retikite | 1.64 (10) | | |
| Flagstaffite,syn | | 0.7 (5) | |
| Simonellite | | | 0.55 (3) |

For TPH concentration against time for crude oil polluted soil with 100g of NPK fertilizer as stimulant. The result shows a significant reduction in TPH from the initial value of 58,200 mg/kg at the commencement of the experiment to 29,183 mg/kg after 90 days of the experiment.

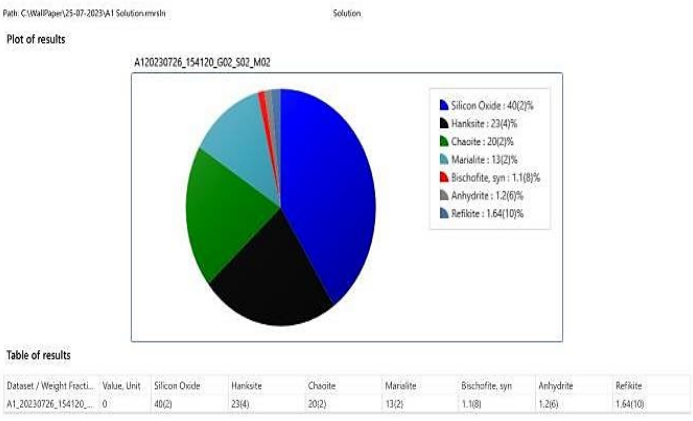


Fig 4: Plot of Result for Native Fowl A1

  

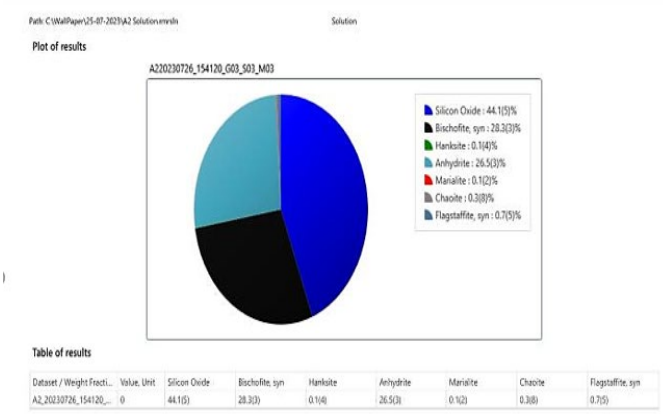


Fig 5: Plot of Result for Duck Fowl A2

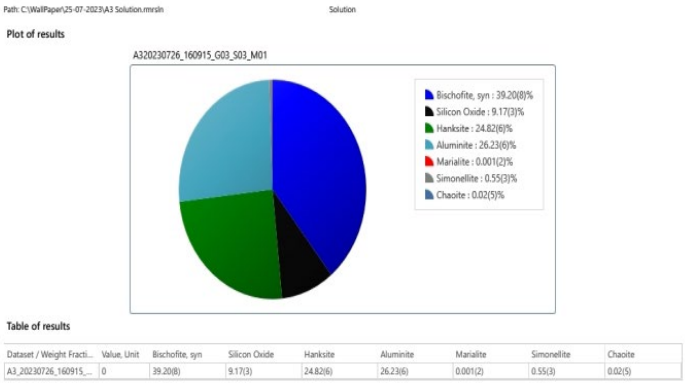


Fig. 6: Plot of Result for Snail A3

The results from table 4.1 showed that Silicon oxide has the biggest fraction and reflection of chemical element of 40.2% and 41.1(5)% for native fowl and duck fowl whereas bischofite which is a mineral exhibited the highest for snail shell samples at 39.20(8)% with high intensity in the X ray diffraction plots.

Furthermore, Table 2 gives the composition of the various eggshells using XRF analysis. From the results, it was seen that the eggshells of native fowl/broiler and duck fowl contains the highest composition of Calcium oxide and silicon oxide and also gave the highest yield of biodiesel in the plot of results/pie chart.

Palm kernel oil in combination with calcium oxide nano-catalyst obtained from broiler/native fowl, duck fowl and snail egg shells exhibited various compounds as well as minerals as shown in the pie chart, in the aftermath of the esterification process and catalyst formation, the plots showed that silicon oxide has the highest catalytic percentage at 44.1 (5)%, as a result, produces the best bio-diesel yield with duck egg shells (Nurul et al., 2020).

Table 2: X-ray Fluorescence for Elemental Composition

| Compound | Elemental Composition A1 / Native / Broiler eggshell | A2 / Duck fowl eggshell | A3 / Snail eggshell |
|---|---|---|---|
| Cao | 8.357 | 15.842 | 7.979 |
| SiO | 61.417 | 28.860 | 23.840 |
| Al2O3 | 9.504 | 21.604 | 22.058 |

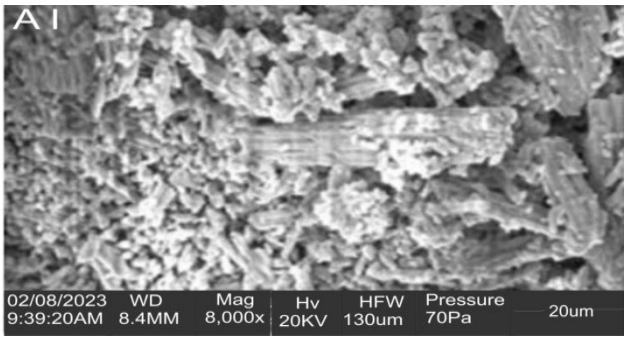


Fig. 7: Native and Broiler Fowl Eggshells A1

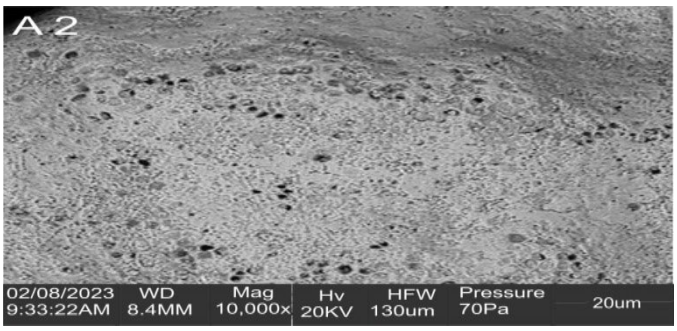


Fig. 8: Duck Fowl Eggshell A2

Table 2 gives the composition of the various eggshells using XRF analysis. From the results, it was observed that the Calcium oxide nano-particles at 15.842 corroborates the results obtained from

  

Table 1 indicating again that duck fowl eggshells exhibits the highest biodiesel yield followed by eggshells of native fowl/broiler composite. In general, it was observed that various formation of ecofriendly compounds and phase names were built up in the process. Moreover, the nano-catalyst was effective in the production of biodiesel using various eggshells in the experimentation. Figure 7 is the transmission electron micrograph with smooth surface corroborates the result, and suggestive of best biodiesel yield obtained from duck fowl eggshell among other egg shells used in the experimentation, whereas Figures 8 and 9 with lower biodiesel yield exhibits rougher surfaces after characterization derived from duck, snail, and native fowl eggshells.

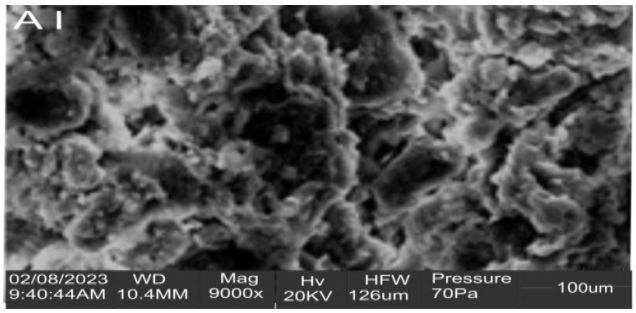


Fig. 9: Snail Eggshell A3

## V. CONCLUSION

The study has successfully produced bioenergy such as biodiesel, solid lubricants and minerals due to the presence of silicon di-oxide, graphite and other compound as well as minerals. As a result, if produced commercially could not only cushion the high cost of fossil fuels but also help to achieve zero carbon emission.

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