Int. j. adv. multidisc. res. stud. 2025; 5(2):826-828

Received: 01-02-2025
Accepted: 11-03-2025

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Synthesis of Catalyst for the Production of Biodiesel: Transesterification Reaction

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Abstract

Catalyst is a chemical compound that speed up the rate of chemical reaction but itself remain unchanged or affected. Therefore, the need for effective and efficient catalyst cannot be overlook, in this regard, this paper seek to investigate the synthesis of catalyst for the production of biodiesel from plant source {Banafruits, cochorus olitorous, avocado pear and dates] using standard method. The results of elemental analysis indicated that banafruits has 1736±0.02mg/l, avocado pear: 599±0.04mg/l,dates palm fruits:625±0.01mg/l and ewedu vegetable {cochorus olitorus] :2221±0.05 while the I R spectrum for banana , pear and dates indicated a broad peaks for -- OH at 2906.69cm, 3118.97cm. and 3144.18cm for banana fruits, pear and dates fruits respectively. In conclusion the present of potassium in all the samples was ascertained and comfirmed present and the broad peaks shows the –OH present.

Keywords: Catalyst, Fruits, flame photometer and I R analysis

Introduction

The use of cleaner fuel bio-derived biodiesel fuel are viable candidate as a renewable target in the transportation sector, therefore the use of effective, economical, stable and eco-friendly catalyst is highly encourage for a good yield in biodiesel processing. Catalyst play a significant role in any catalytic chemical reaction, one of such is transeterification reaction of vegetable oil and alcohol in biodiesel production. The reason why sodium or sodium hydroxide or ethyloxide is recommended is because of there properties in terms of high conversion, workable at their best quality, minimum time of reaction, good catalytic activity and economical, with few demerit, soap and free fatty acid formation.

Catalyst are substance in form of metal compound or polymeric material either in organic form or inorganic. The major purpose in any reaction is to speeds up the rate of chemical reaction. Catalyst can be categorized into two: Homogeneous and heterogenous catalyst. The common catalyst use in transesterification reaction are either chemically based or biological in form of an enzymes, example of chemical based are: sodium hydroxide, potassium, calcium hydroxide and are classified as homogenous catalyst. The homogeneous catalyst are also divided into homogenous acid catalyst and homogeneous base catalyst. There are also heterogenous catalyst which arise as a result of cost undertaken in the preparation of homogenous catalyst and that, there are no formation of soap. They are also divided into heterogenous base catalyst and heterogenous acid catalyst. The solid base catalyst are more active than the solid acid catalyst. Some of the common solid base heterogenous catalyst are: basic zeolite, alkali metal oxide and hydrotalcites. While heterogenous solid acids include: Nafion -- NR 50, tungstatel etc. Baskar *et al*. 2018. There are two main theories o catalysis; Intermediate compound formation theory and The adsorption theory. In general, the intermediate compound formation theory applies to homogeneous catalytic reactions and adsorption theory applies to heterogenous catalytic reactions.The Intermediate Compound Formation Theory: A catalyst

functions by providing a new pathway of lowering the activation energy in homogeneous catalysis. It does so by forming an intermediate compound then react with the second reactant to yield the product releasing the catalyst.

$$A + B \xrightarrow{C} AB \quad (1)$$

Where C act as catalyst. The reaction proceeds through the reaction.

$$A + B \longrightarrow AC \quad (2)$$

$$AC + B \xrightarrow{\text{intermediate}} AB + C \quad (3)$$

The activation energy reaction 2&3 are lower than that of the reaction 1 Hence, the involvement of the catalyst in the formation of the intermediate compound and its subsequent decomposition accelerate the rate of reaction 1 which is originally very low.

Banana fruits: (musa species): *musas paradisiacal*, it belong to the family called *musaceae* that used to grow to a height of 3 to 5meters. The banana is the most consumed fruits in the world. The fruits can be eaten anywhere without the need for napkin or a knife in the world and as part of balance diet, and is rich in potassium (1736±0.04mg/l). It comes wrapped in its own natural hygienic packaging. It is one of the nutritious fruits and medicinal. The catalyst generated from it is **Potassium hydroxide.**

Cochorus olitorous is a name of plant that has a common name called Ewedu vegetable. The vegetable is consumed as soup for food like yam, elubo, eba, cassava flour and others. It serve majorly as a source of iron in food for body building and use. The solution of this vegetable resemble okro solution but analysis of this vegetable indicated that it contain a very large amount of sodium as shown from its elemental analysis, (2216mg±0.05g/l). This was what lead to the idea of synthesis a catalyst from the plant. The catalyst syntheses from the plant was **Sodium Hydroxide.**

Avocado Pear is a plant tree that grown mostly southern part of Nigeria. It belong to evergreen tree that belong to botanical family called *lauraceae* that grows to a height of 16 meters. It is grown purposely as a source of mono, di and tri glycerides for food and it goes well with cooked rice with good soup. It has a hard soft seed almost oblong in shape and it can be use as a source of oil. It contain almost 48% of oil that can serve as feed stock for biodiesel production. The succulent part of the fruits has large amount of potassium. (abundant). The catalyst syntheses from the fruits is **Potassium hydroxide.**

Dates palm: It is tree plant that belong to botanical family called *palmaceae.* It used to produced many brown colour fruits, slightly soft internal in its endosperm layer while it has protective outer layer of epicarp (brown). It contain one stony seed per fruits. It is one of the energy rich and nutritious as food. It is rich in minerals mostly potassium and others like iron, magnesium phosphorous and calcium. The catalyst generated is **potassium hydroxide.**

Statistical analysis: The of the analysis was subjected to analysis of variance. (ANOVA) to ascertain the source of variance. Least significant difference (LSD) test was use to determine if there was significant different between mean. The significant The significant was p >0.05.

Experimental

Material and Methods

Sample preparation: Ewedu vegetable was planted in my garden in University premises, grown and maintain till maturity. The mature plant was harvested, watched, open dried and latter oven dried at 50ºC for 4 – 5hours and remove from oven for blending using kenwood blender. The powder was kept in cleaned dried PVC plastic. Until when needed.

Pear fruits was also purchased from University premises. The soft cover of the fruits was removed with a knife and the softer succulent butter like substance was removed living the hard seed brownish in colour. The butter-like soft material was gather together, in a air tight container and store until when needed. Dates fruits was treated the same.

Methods: 200g of powder ewedu was weight on a mettlar balance M301 with big crussible and placed inside a furnace at 550ºC and heated for 1 – 2hours. The ashed sample was mixed with distilled water and stirred properly and filtered, the filtrate was crystallized. The crystal was packed inside a cleaned dried sample bottle for laboratory test and analysis 200g of sample 2 (pear) butter like sample was weight on a balance inside a big crucible and placed inside a furnace heated at 550ºC for 2-4hours, the ashed sample was cooled and distilled added to dissolve the content and latter filtered and crystallized. The crystal was kept in a cleaned dried sample bottle making ready for laboratory test and analysis.

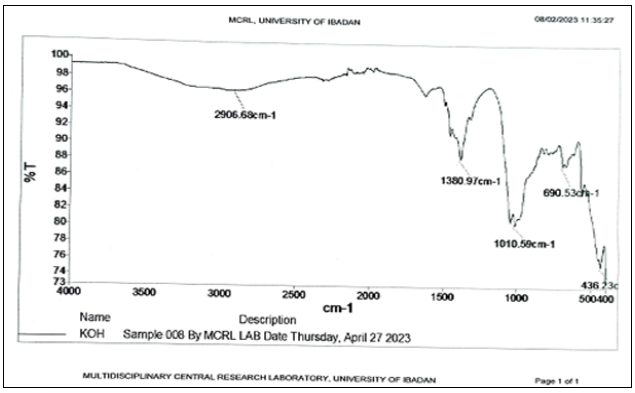
Sample 3 (banana and dates). The dwarf ripe banana fruits was also treated and dates palm fruits as above.

Flame Photometer: This equipment was used to analysed the present of potassium (K) metal, In all the prepared samples using standard methods A.O.A.C (1995) [1].

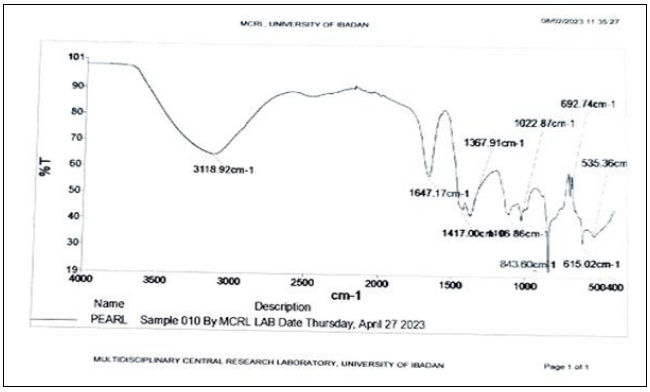
Infra Red Spectrophotometer was also use to run the spectrum in other to detect the functional group present. Using standard method A.O.A.C (1995) [1].

Results and Discussion

Banana spectrum for K O H.



Pear fruits spectrum for K O H.



Dates fruits spectrum for KOH.

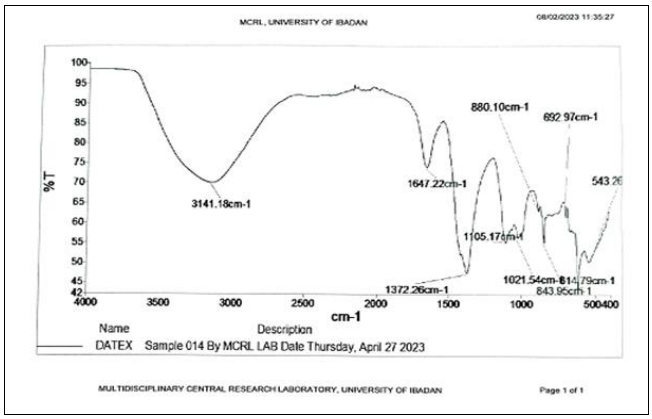


Table 1: Flame photometer analysis results

Parameters	Amounts (mg/l)
Banana fruits [potassium]	1736±0.02
Avocado Pear fruits“	599±0.04
Dates palm fruits“	625±0.01
Ewedu vegetable [Sodium]	2216±0.05

Table 1 above shows the flame photometer analysis results of fruits and ewedu vegetable. The value observe for banana fruits was 1736±0.02mg/l for potassium. The value is lower to that observed for ewedu vegetable: 2216±0.04mg/l as reported by Owoeye *et al*. 2018 [5]. The values observe for avocado and dates palm were: 599±0.04mg/l and 625±0.02 mg/l respectively. While that of the ewedu was 2216±0.05mg/l. The observed value for banana was the higher among the first three study samples except for ewedu that has the highest among all the samples. The pH value for all was basic, depending on the concentration it reads up to 13 and 14 in value when tested with pH value indicator paper. Testing with different indicator was also positive to all basic medium.

More over, the first Spectrum shows the peaks for banana spectrum indicating four major peaks at 2906.68cm^{-1}, 1380.97cm^{-1}, 1010.58cm-1, 690.53cm-1 that of pear has a broad peaks at 3118.92cm^{-1}, and other six major peaks which are 1647.17cm^{-1}, 1417.00cm-11367.91cm^{-1}, 1106.86cm^{-1}, 843.60cm^{-1} and 692.74cm-1 while, dates palm has broad peak at 3141.18cm^{-1}, and other major seven peaks which are 1647.22cm^{-1}, 1372.26cm^{-1}, 1105.17cm^{-1}, 1021.54cm^{-1} 880.50cm^{-1} and 843.95cm^{-1} All the broad peaks values falls within the value on the data table that reads 2500cm^{-1} ----- 3000cm^{-1} for ---OH. Other peaks at 1647.17cm^{-1} for pear and 1647.22cm^{-1} for dates indicated the present of carbonyl C =O that is within 1630cm^{-1} ----- 1780cm^{-1} but it is absent in banana spectrum. Other similar peaks to the three spectrum were: pear peaks at 1367.91cm^{-1} and dates at 1372.26cm^{-1} while banana peaks at 1380.97cm^{-1} they belong to C- H alkyl stretching at 1380cm^{-1} --- 1385cm^{-1} for isopropyl also at 690.53cm^{-1} for banana, 692.74cm^{-1} for pear and 692.97cm^{-1} for dates are peaks for mono substituted aromatics and m Di-substituted at 690cm^{-1} --- 710cm^{-1} and 680cm-1 ---725cm^{-1} that are very strong and strong peaks respectively. There is para aromatic Di-substituted at 843.60cm-1 and 843.95cm-1 for pears and dates respectively and is similar to data value peaks at 800cm^{-1} -840cm^{-1}.

Furthermore, from the above observation and analysis, it indicated that the presence of --- OH in all the samples and elemental analysis results shows that potassium and sodium hydroxide were present in all the samples concerned, and they are recommended as a good sources of the catalyst. These catalyst are normally use because of the following properties: They has the best operative condition. High conversion rate within minimum time and economical.

Conclusion

The analysis conducted with all the samples were positive and the spectrum confirm the present of hydroxide and the flame photometer read out indicated values that show the present of potassium in all samples. Therefore, it is confirm and ascertained that potassium hydroxide is present in all the samples and sodium in ewedu samples and that they are recommended as a catalyst suitable for transesterification reaction process, because when used in biodiesel production the results were also good with high yield.

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