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RESEARCH ARTICLE

EVALUATING AVOCADO (*PERSEA AMERICANA*) FOR ECO-FRIENDLY BIOFUEL PRODUCTION

Authors: Andrea Mae C. Santiago*, Angelika C. Alejandro, Leanne Mae Meneses, Jastine Joy Basilio, Diane Kristiane G. Espinosa, Patricia R. Placiente, Alexandra Nicole Luna, Gesreel P. Mendoza, Aira Jheanne M. Rufino, Tiffany Lorraine DG. Lopez, Sofia Beatriz Estayan, Jhoselle Tus, & Francis Rayo

Corresponding author email: santiagoandrea@jilcf.edu.ph

Abstract

Biofuels have emerged as a promising candidate for renewable energy, but their production processes can still contribute to greenhouse gas emissions. This study explores avocados' potential as a raw material for biodiesel production. Beyond their role as a food product, avocados offer a relatively safe biofuel production method, as their processing emits minimal hazardous chemicals. Avocado oil is rich in fatty acids, which are crucial for transesterification—a critical reaction in creating monoglycerides essential for biofuel. The history of biofuel development, with Rudolf Diesel's peanut oil experiments and Henry Ford's ethanol-powered model, highlights the longstanding interest in plant-based energy sources. This research aims to address the existing gaps by investigating the viability of avocados in biodiesel production, emphasizing their environmental benefits and efficiency.

Keywords: *persea americana, eco-friendly, biofuel*

Introduction

In an era marked by a global shift toward sustainable energy solutions and environmentally friendly resources, the current study aims to explore the potential of avocados as an alternative feedstock for biofuel production. As outlined by Rachimoellah et al. (2009), a chemical process called transesterification is typically used to convert vegetable oil and alcohol into fatty acid esters and biodiesel, with glycerol emerging as a valuable byproduct. This chemical reaction is catalyzed to facilitate the breakdown and transformation of the oil molecules. Given the rising demand for alternative energy resources and the pressing need to reduce dependency on fossil fuels, this research endeavors to investigate the feasibility of using avocado oil for biodiesel production. Furthermore, the study focuses on the comparative analysis of two critical washing techniques—dry washing and washing with water—to identify the most efficient and effective method for refining the biodiesel product. The findings of this study could help establish that avocado seed oil possesses the essential properties and characteristics necessary to qualify as a viable and sustainable alternative to conventional biodiesel sources.

Research Objectives

The primary objective of this study is to rigorously evaluate the feasibility and potential of avocado oil as a candidate for biofuel production. More specifically, the research aims to investigate its efficiency, cost-effectiveness, and environmental impact compared to leading biofuels, such as those derived from soybean oil, ethanol, and other biodiesel products. By examining the potential benefits and limitations of avocado oil, this study seeks to contribute to the broader understanding of natural and renewable energy resources. Recent advances in microbial biofuel production and microalgal cultivation strategies, recognized as direct energy conversion methods for biofuels, have prompted a renewed interest in exploring alternative biofuels. Consequently, the researchers aim to expand these possibilities by introducing avocado oil as a promising new candidate for biofuel production. Global biofuel production, while still relatively modest, has been on a steady rise, driven by international efforts to reduce greenhouse gas emissions and transition away from traditional fossil fuels (Ajanovic, 2011). Nevertheless, it is crucial to acknowledge the environmental risks associated with fossil energy, which include a high carbon footprint and significant ecological damage. The consumption and demand for fossil fuels are expected to grow, highlighting the urgency of identifying alternative energy sources that offer minimal environmental harm and greenhouse gas emissions (Rodionova et al., 2017). The study's specific objectives include:

- Evaluating the amount of energy that can be efficiently extracted from avocado oil.
- Determining the unique properties of avocado oil biofuel and comparing its performance to other existing biofuels.

- Assessing the environmental impact of avocado oil biofuel production, particularly in emissions and land and water usage.
- Maximizing its economic viability and market competitiveness in the current energy landscape.

Literature Review

Local Literature

In the Philippines, the Biofuels Act, officially known as Republic Act 9367, was passed in 2007 to mandate the integration of biofuels into petroleum-based fuels. This legislation aimed to achieve multiple goals, including energy independence, the generation of rural employment, and the reduction of greenhouse gas emissions. According to the law, all petroleum fuels were required to contain a blend of 20% bioethanol and 10% biodiesel by the year 2020. Feedstocks such as sugarcane and molasses are commonly used in bioethanol synthesis, while other renewable sources are continually being explored to diversify biofuel production. Avocado oil, a byproduct of the avocado fruit native to Central America and Mexico, has also gained attention as a potential biofuel candidate. In the Philippines, avocado cultivation has expanded, making it a viable resource for biofuel production. A study conducted by Dela Rosa et al. (2018) demonstrated that avocado oil could serve as a feedstock for biodiesel, with yields reaching as high as 93%. The research further highlighted that avocado oil-based biodiesel shares similar properties with traditional diesel fuel, suggesting its suitability for diesel engines.

Foreign Literature

Brazil, which accounts for approximately one-third of the world's soybean production, has achieved considerable success in agribusiness due to its well-developed soybean production chain. Soybeans, which contain around 19% to 20% oil, undergo a refining process to produce high-quality oil. This process, which includes degumming, neutralization, deodorization, and cleaning, is essential for optimizing oil extraction. Degummed soybean oil is a cost-effective option and is widely utilized in biodiesel production due to its similar chemical composition to refined oil. Estevez et al. (2022) explained that transesterification is the preferred method for biodiesel production, as it facilitates the conversion of triglycerides into fatty acids, alkyl esters, and glycerin through a reaction with alcohol in the presence of a catalyst. Given the sensitivity of transesterification to acid catalysis, a pre-treatment step is required to mitigate the risk of moisture absorption. Additionally, Estevez et al. (2022) emphasized the potential benefits of using dimethyl carbonate as a biodegradable solvent to replace glycerol in biodiesel synthesis, thereby reducing production costs. Researchers Kusdiana and Saka identified key factors—reaction temperature, pressure, duration, and molar ratio of reactant/solvent to oil—that must be controlled to optimize supercritical esterification and transesterification reactions. Recent studies have recognized green hydrogen as the best alternative to fossil fuels, but biofuel remains a close second due to its ease of integration into existing energy systems. Nevertheless, the challenge of managing excess glycerol generated during transesterification must be addressed through technological innovations, such as green diesel production (Nunes et al., 2023).

Methodology

The research methodology involves the preparation of avocado oil for biofuel production using a series of carefully designed steps. The required materials, which include avocado oil, methanol, and potassium hydroxide, are readily available in most school laboratories, public markets, and online suppliers. However, specialized equipment like food filters is necessary to refine and separate the biofuel. To ensure an efficient and error-free process, all essential materials must be gathered in advance. The experimental procedure is as follows:

- Measure 100 ml of pure avocado oil and pour it into a beaker.
- Heat the beaker containing the avocado oil on an electric stove to a temperature of 55-60°C for approximately 2 to 3 minutes.
- While the oil is being heated, continuously stir and monitor the temperature.
- Prepare a catalyst mixture by combining 20 ml of methanol and 0.85 g of potassium hydroxide to create a methoxide solution.
- Once the avocado oil has reached the desired temperature, turn off the electric stove.
- Gradually add the methoxide solution to the heated avocado oil while stirring continuously.
- Transfer the mixture into an airtight container and allow it to sit undisturbed for 24 hours.
- After 24 hours, the separation of biofuel and glycerin should be clearly visible, with biofuel floating on top and glycerin settled at the bottom.
- Filter the biofuel using a food strainer three times to ensure purity.
- Properly dispose of any residual glycerin remaining in the food strainer.
- The resulting biofuel, now cleaner and safer, is suitable for use as an alternative fuel for agricultural machinery and vehicles.

This methodology utilizes the principles of transesterification, which involve mixing methanol with potassium hydroxide to create a catalyst and then combining this mixture with heated avocado oil. The tight sealing and settling process, as outlined by Dagde (2019) and Hossain et al. (2012), ensures the separation of glycerin from the biofuel.

Results and Discussion

The findings indicate that biofuels derived from methanol, vegetable oils, and recycled cooking oils represent a promising alternative to conventional petroleum diesel for vehicle usage. Effective management of the separation process is crucial, as excess glycerin can lead to contamination and storage issues, ultimately reducing engine efficiency and lifespan. While the cost of isolating glycerin is relatively low, the process can be slow and requires careful monitoring to achieve optimal results. To ensure maximum purity, the filtration procedure must be repeated at least three times.

Conclusion

This study underscores the potential of biofuels to lessen our dependence on fossil fuels, particularly in the Philippines, where the heavy reliance on imported oil has significant economic and environmental implications. The development of alternative local sources of energy would greatly benefit farmers and contribute to mitigating the impact of rising fuel prices. Furthermore, the increasing global concern over carbon emissions and the environmental impact of fossil fuel consumption underscores the importance of finding alternative energy solutions. While fossil fuels have historically been the dominant energy source, their continued use poses considerable environmental risks, including greenhouse gas emissions and pollution. By exploring the use of avocado oil as a potential biofuel feedstock, the researchers aim to offer a viable solution to these challenges. Through a thorough examination of existing literature and the successful implementation of a tested methodology, this study establishes that avocado oil holds promise as a renewable energy source.

Based on the research findings, several key recommendations can be made for further exploration and utilization of avocado oil as a renewable energy source. First and foremost, additional studies should be conducted to optimize the extraction techniques for avocado oil, with a particular focus on factors such as greenhouse gas emissions, land use, water consumption, and biodiversity impact. Investigating synergies between avocado oil production and sustainable agricultural practices, such as agroforestry or organic farming, could enhance land and resource management while supporting environmental conservation efforts. Moreover, it is essential to examine the compatibility of avocado oil biofuel with existing engine technologies and explore potential modifications to improve performance and reduce emissions.

References

Acda, M. N. (2022). Production, regulation, and standardization of biofuels: A Philippine perspective. Value-Chain of Biofuels, pp. 553–570.

Ajanovic, A. (2011). Biofuels versus food production: Does biofuels production increase food prices? Energy, 36(4), 2070-2076. https://doi.org/10.1016/j.energy.2010.05.019

Cloin, J. (2005). Biofuels in the Pacific.6(4), 45–48. https://doi.org/10.1016/s1471-0846(05)70431-5

Dagde, K. K. (2019). Extraction of vegetable oil from avocado seeds for the production of biodiesel. Journal of Applied Sciences and Environmental Management, 23(2), 215. https://doi.org/10.4314/jasem.v23i2.3

Dagde, K. K. (2019). Extraction of vegetable oil from avocado seeds for production of biodiesel. Journal of Applied Sciences and Environmental Management. https://doi.org/10.4314/jasem.v23i2.3

Dornburg, V., van Vuuren, D. P., & Faaij, A. P. (2010). Impact of bioenergy on income and employment in rural areas. Environmental Science & Policy, 13(1), 85-103.

Economics of Biofuels | US EPA. (2014, April 17). US EPA. https://www.epa.gov/environmental-economics/economics-biofuels#:~:text=Replacing%20fossil%20fuels%20with%20biofuels,dependence%20on%20unstable%20foreign%20s uppliers.

García-Vargas, M. C., Contreras, M. del M., & Castro, E. (2020). Avocado-Derived Biomass as a Source of Bioenergy and Bioproducts. Applied Sciences, 10(22), 8195. https://doi.org/10.1016/B978-0-12-824388-6.00001-4

Mechanistic model for the batch extraction of oil from avocado seeds available for biofuel production. (2021). International Journal of Green Energy. https://www.tandfonline.com/doi/abs/10.1080/15435075.2021.1930001?journalCode=ljg e20

Nunes, A. L. B., Vernier, L. J., Albarello, M., & de Castilhos, F. (2023). Non-catalytic production of fatty acid methyl esters from degummed soybean oil and supercritical dimethyl carbonate in a tubular reactor. The Journal of Supercritical Fluids, 198, 105921. https://doi.org/10.1016/j.supflu.2023.105921

Paul, A. A. L., & Adewale, F. J. (2018). Data on optimization of production parameters on Persea Americana (Avocado) plant oil biodiesel yield and quality. Data in Brief, 20, 855–863. https://doi.org/10.1016/j.dib.2018.08.064

Rachimoellah, H & Resti, Dyah & Zibbeni, Ali & Susila, Wayan. (2009). Production of Biodiesel through Transesterification of Avocado (Persea gratissima) Seed Oil Using Base Catalyst. Jurnal Teknik Mesin. 11.

Rodionova, M., Poudyal, R., Tiwari, I., Voloshin, R., Zharmukhamedov, S., Nam, H., Zayadan, B., Bruce, B., Hou, H., & Allakhverdiev, S. (2017). Biofuel production: Challenges and opportunities. International Journal of Hydrogen Energy, 42(12), 8450–8461. https://doi.org/10.1016/j.ijhydene.2016.11.125

Sathish, S., Narendrakumar, G., Vaithyasubramanian, S., & Sinduri, E. (2021). Mechanistic model for the batch extraction of oil from avocado seeds available for biofuel production. International Journal of Green Energy, 18(15), 1645–1657. https://doi.org/10.1080/15435075.2021.1930001