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Design and Development of Biofuel and Chicken Feed (Broilers) for Janitor Fish (Pterygoplichthys) Utilizing AVR Microcontroller (Esp32)

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Abstract

Liquid biofuels are emerging as a sustainable and eco-friendly alternative to fossil fuels, with versatile applications from transportation to heating. This study aims to produce biofuel from janitor fish, an invasive species with a high fatty acid content that can be used as animal feed because of its high protein content. This combined strategy seeks to reduce environmental impact while utilizing the biomass of the species for energy and nutritional purposes. The research goal was to automate extracting biofuel from janitor fish and turning the remaining biomass into chicken feed. The experimental setup comprised a pyrolysis process of 12 kilograms of janitor fish with 21 liters of water to extract bio-oil. The system included four modules: boiling, grinding, separating, and sensor, designed to make conversion operations more efficient. The results showed a high system efficacy, with biofuel production obtaining 97% accuracy for outputs ranging from 450 to 500 ml and chicken feed production achieving 98% accuracy for 12 kilograms feed. Biofuel quality remained similar throughout experiments, with 98% accuracy in "gasera" life ratings. Furthermore, two-day trials of chicken feed proved its nutritional sufficiency and acceptability, with an overall accuracy of 96% in projected weight growth. Finally, the study demonstrated the successful use of janitor fish to produce biofuel and chicken feed, emphasizing the system's potential contribution to sustainable energy and agriculture. Comprehensive testing confirmed the system's performance, demonstrating its dependability and usefulness in converting a hazardous species into beneficial resources.

Keywords: Pterygoplichthys, Janitor Fish, Biofuel, Chicken Feed, Pyrolysis, AVR Microcontroller (Esp32)

INTRODUCTION

Liquid biofuels are becoming more significant on the energy front as a clean and effective renewable energy source with a wide range of applications, including transportation, power generation, and traditional usage such as lamps and alcohol stoves (Chiong et al., 2018). Biofuel is made from biomass material and is frequently utilized as a more environmentally friendly fuel source than burning fossil fuels. According to Arjoon and Speight (2021), even though fossil fuel and biofuel are made from organic matter, the organic matter's disintegration date varies.

Based on the article by Nigam and Singh (2011) about producing liquid biofuel from renewable resources, biomass-based fuels now appear to be the only sensible option for sustainable growth when considering economic and environmental factors. Researchers have been refocusing their attention in this area. Liquid biofuels may be produced from leftover agricultural biomass and trash, which are globally accessible sources of renewable bioresources.

Chiong et al. (2018) stated that the rising need for clean energy drives the development of alternative fuels, such as diverse liquid biofuels and hydrogenated vegetable oil (HVO). While HVO and Fischer Tropsch (FT) fuels have high manufacturing costs, they are suited for aviation turbines and show promise in lowering emissions in gas turbines. Although they need improvements in Fuel supply and atomization technology, biodiesel, bioethanol, bio-oil, and

straight vegetable oil (SVO) are all feasible possibilities for stationary power production turbines. Understanding their combustion characteristics is essential for these fuels to be widely used in gas turbine applications, providing cleaner and more sustainable energy solutions.

Originally introduced to rivers to keep the water clean, janitor fish have grown out of hand and are now considered a nuisance to the environment. However, because of their high fatty acid content, which makes them perfect for the conversion of biodiesel, this fish has a great deal of potential for producing biofuels. Using janitor fish as the main resource, the thermochemical process of pyrolysis converts this biomass into bio-oil. Also, because janitor fish has a high protein content, scientists in the Philippines are investigating if it is feasible to use them as a source of nutrition in animal feeds, which might provide value to what is now thought of as an invasive species.

Janet, a science teacher, was chosen by Marikina Mayor Marides Fernando to be a member of the Benefish Committee to address the issue of janitor fish in the Marikina River. In a scientific project at school, her son Raymond Joseph Amurao learned about using fish flesh from janitor fish in commercial chicken feeds. He was only sixteen when he was assigned to boil the fish on Saturday, but instead, he played basketball. He returned after thirty minutes, forgetting that the entire thing was meant to be steam-cooked for ten minutes. Raymond saw fish oil floating on the soup during an unintentional boiling experiment. He was intrigued and investigated other applications, learning about biodiesel made from animal fat. Raymond's experiment created five hundred milliliters of biofuel with a fuel value equivalent to diesel using 12 kilograms of janitor fish ("Stunning interesting facts"). With the above instance, janitor fish is therefore a new source of biofuel.

Assessing the impact on broiler performance and overall feed cost per kilogram of gain of substituting soybean meal or poultry by-product meal for fish meal in broiler diets. According to Frempong et al. (2019), broiler chickens in developing nations frequently get their protein from fish meals. It has a lot of fat, critical amino acids, vitamins, and minerals. Conversely, fish meals can give meat and eggs a fishy flavor and odor, but they are getting more complicated and expensive. Scientists are therefore looking into plant-based protein sources for the diets of broiler chickens. The most widely used plant protein sources for broiler diets worldwide are groundnut meal, cottonseed meal, full-fat soybean meal, soybean meal canola meal, rapeseed meal, and leaf protein concentrate.

METHODOLOGY

Figure 1 is the block diagram of the prototype where you can see how every component connected into the AVR microcontroller Espressif32 (ESP 32), it is the visual representation of this prototype to represent the relationship between all the components and how does the prototype work according to organization.

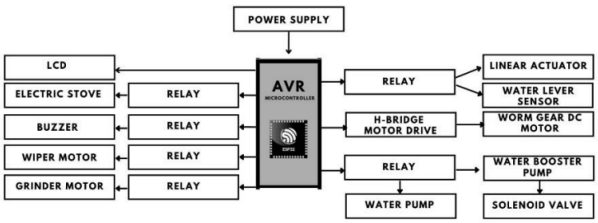

Figure 1
Block Diagram of the Prototype

The framework (Figure 2) is divided into three sections: "Input," "Process," and "Output." Alternating current (AC) was chosen as the primary energy source to ensure the system's proper operation across its various modules. The process will have all the steps that are needed to get the work done in the system. The input consists of an AC source to power the different modules that will be mentioned later. The "Janitor Fish and water" is the primary ingredient to get biofuel and chicken feed. This ingredient will be put in the Tank, and the electric stove will heat the tank and boil the fish which will extract the oil from the fish then the buzzer will notify the user that the timer is done

boiling. The Wiper Motor lifts the cooked janitor fish and is pushed by the linear actuator through the grinding module, as for the water-oil from the tank, it will be moved to the Separation module by the water pump. The separation module contains storage with a water level sensor that will keep the water oil from overflowing.

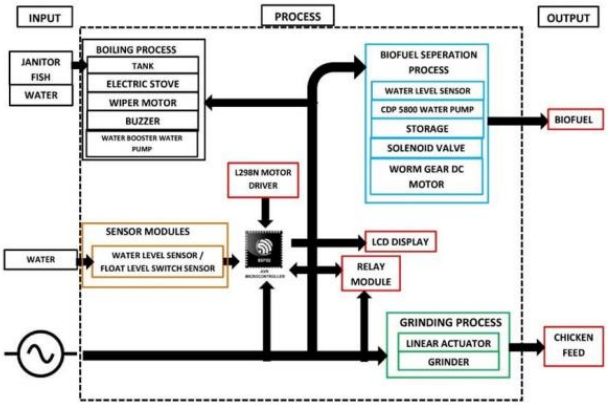

Figure 2
Conceptual Framework

The LCD is a type of flat panel display which uses liquid crystals in its primary form of operation. The display will show real time data procedure of the whole system. Additionally, the project will produce chicken feed, with a target output weight of 11-12 kilograms.

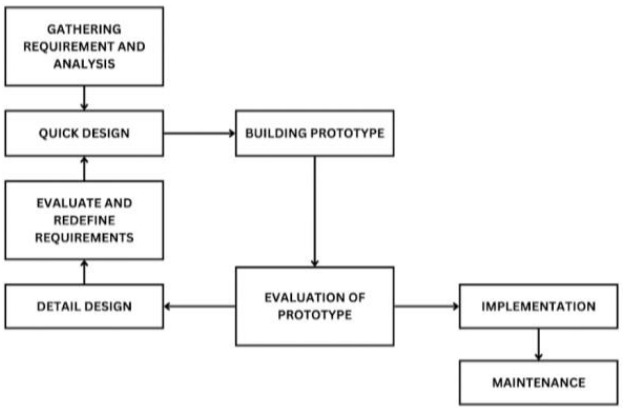

Figure 3
Prototyping Model

The research approach involved the extraction of biofuel and chicken feed (broilers) from Pterygoplichthys using AVR Microcontroller (ESP32). It involved the use of descriptive applied research to build and implement an automated system and developmental research design to improve current practice or develop solutions to existing problems.

RESULTS AND DISCUSSION

Functionality Test. By comparing the biofuel production capabilities of an automated system to traditional manual boiling methods for janitor fish, it is clear that the automated system provides significant advancements in efficiency and consistency.

Table 1
Biofuel Accuracy Test Output

No. of Trials	Actual Measurement Reference: 450-500 ml
1	450
2	455
3	450
4	500
5	470
Total	2,325
Mean	465
Percent Error	3%
Accuracy	97%

The traditional approach, while capable of producing comparable volumes of biofuel (usually around 500 ml), is significantly reliant on human interaction, which adds unpredictability in heating time and quantity, influencing both the quantity and the quality of the biofuel extracted. In contrast, the automated system, as demonstrated in Table 1 of the study, delivers a remarkable 97% accuracy in biofuel production using controlled and exact operational parameters. This method not only standardizes the process to reduce human error, but it also improves the reproducibility of biofuel production.

However, it is highlighted that there is a 3% error margin, which is primarily due to inefficiencies in the separation module and indicates possible areas for improvement. This comparison highlights the technological superiority of the automated approach, which not only aligns with enhanced productivity goals but also ensures the sustainability and

environmental purity of biofuel production from invasive species such as the janitor fish.

Table 2
Chicken Feed Accuracy Test Output

No. of Trials	Actual Measurement Reference: 12kg
1	11.8kg
2	11.8kg
3	12kg
4	11.7kg
5	11.9kg
Total	59.2
Mean	11.84
Percent Error	2%
Accuracy	98%

Compared to traditional methods, the automated system detailed in Table 2 offers significant advancements in producing chicken feed from janitor fish. Traditional methods are labor-intensive and costly, often resulting in inconsistencies in feed quality. In contrast, the automated system achieves a 98% accuracy rate, enhancing efficiency and consistency while reducing labor costs. This automation not only streamlines production but also ensures a higher quality feed, meeting the nutritional needs of broilers more effectively and potentially transforming poultry farming practices by offering a scalable, economically viable alternative.

Validation of Results. The functionality of the biofuel generated from Pterygoplichthys (Janitor Fish) was validated by testing its ability to run a "gasera" lamp. Table 3 shows that 500 milliliters of biofuel may effectively power a "gasera" lamp for up to 20 hours. This finding highlight biofuel's potential as a sustainable and effective energy source.

The study validates the biofuel's usefulness in both conventional and modern energy solutions, establishing it as a vital asset in the goal of energy sustainability. This novel strategy to harnessing an invasive species not only adds to sustainable energy practices, but also paves the way for future research and development in the field.

Figure 4
"Gasera" using biofuel

Table 3
Assessing "Gasera" Life: 500ml Biofuel Effectiveness Duration

No. of Trials	Actual Hour Reference: 20hrs
1	19.6 hrs
2	19.7 hrs
3	19.5 hrs
4	19.9 hrs
5	19.9 hrs
Total	98.6
Mean	19.72
Percent Error	2%
Accuracy	98%

Figure 5
Broilers are fed with chicken feed

Table 4
Evaluating the effectiveness of chicken feed by feeding it to broilers 3x a day, Day2

No. of Trials	Actual Measurement Reference: 0.5 – 1kg
1	0.75kg
2	0.75kg
3	0.7kg
4	0.75kg
5	0.68kg
Total	3.63
Mean	0.72
Percent Error	4%
Accuracy	96%

A practical feeding trial with broilers over a two-day period was used to validate chicken feed derived from janitor fish, with results documented in Table 4. The study involved tracking the weight gain of broilers starting at 0.5 kg and receiving the janitor fish-based feed three times a day. The results of this controlled experiment show that encouraging weight gain in broilers is highly effective, with an overall accuracy rate of 96%. This discovery highlights the potential of janitor fish as a viable source of chicken feed, helping to promote sustainable poultry farming practices.

Figure 6
Final and Actual Prototype

Conclusion. The "Design and Development of Biofuel and Chicken Feed (Broilers) for Janitor Fish (Pterygoplichthys)" automated system successfully extracted biofuel from janitor fish, giving a sustainable alternative that benefits invasive species. With the integration of AVR Microcontroller (ESP32) technology, the system efficiently automates the conversion of janitor fish into valuable resources among its three specialized modules, each with sensors and actuators. The system's separation module facilitates the biofuel extraction process, which efficiently manages up to nine liters of water. This module's precision, aided by the Float Water Level Sensor and the pyrolysis process, enables precise separation.

Furthermore, the technology converts extra fish waste into high-quality chicken feed, which promotes sustainable agriculture methods. Functionality tests and quality assessments for the boiling, grinding, and separating modules confirm the system's dependability and effectiveness. Despite a 3% difference in biofuel generation, which indicates possible improvements, notably in the separation phase, the system demonstrates its value as an innovative solution to environmental concerns.

Future Works. Future enhancements to the automated system are recommended to improve its efficiency and applicability. Optimizing total processing time is critical for improving the system's energy efficiency; replacing the Electric Stove component with a more efficient heating element could speed up procedures without sacrificing precision. Upgrading the lifting mechanism to a more robust pulley system may minimize maintenance requirements while increasing durability, particularly in oil-rich conditions. Expanding the system's capacity to hold more than 12kg of janitor fish per cycle might greatly increase biofuel and chicken feed output, boosting total productivity. Furthermore, using a pelletizer machine would enable the creation of denser and more nutritious chicken feed, simulating commercial feeds as well as enhancing broiler health and growth. These proposed enhancements aim to lower the

system's energy usage, improve output quality, and assure project scalability and sustainability.

Acknowledgement. Above all, the proponents want to give the venture to Almighty God for proficiency, inspiration, determination, good health, and endurance for great fortitude. He gives us the strength to make this capstone project possible.

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