Fish Drying Chamber Utilizing Salinity and Moisture Content Using ATmega328P

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ABSTRACT

The fish drying chamber that uses salinity and moisture content and is controlled by an Atmega328P is a technological breakthrough representing a significant advancement in fish drying processes. The use of this chamber has the potential to revolutionize the traditional fish drying process, which is frequently inefficient and inconsistent. The goal of this technology is to ensure that fish is dried evenly and that the required moisture content and salinity levels are met to produce high-quality dried fish. A thermostat sensor monitors the chamber's temperature, and a load cell sensor measures the weight of the fish before and after drying. The system can indirectly measure the moisture content of the fish by measuring the weight of the fish before and after drying.

A salinometer is also used to regulate the salinity of the fish, ensuring consistent variations in salinity. Consistent salinity levels must be maintained during the drying process to ensure the fish is evenly dried and retains its quality. The drying process within the chamber is meticulously monitored to ensure that the fish is evenly dried and that the desired moisture content and salinity levels are met. Fish farmers and processors can use this technology to produce high-quality, evenly dried fish that meets market standards. The fish drying chamber utilizing salinity and moisture content using Atmega328P is a significant technological advancement that can improve the efficiency and consistency of fish drying processes.

Keywords: drying chamber, salinity, moisture content, dried fish, ATMega328P microcontroller.

INTRODUCTION

Fish is a nutritious food with both macro and micronutrients, making it a beneficial dietary option for human health. Although it is prone to spoilage, various techniques have been developed to prevent this, such as the common sun-drying method. This preservation method prolongs the shelf life of fish, allowing for a longer consumption period [1-2]. According to the study [3], salting fish can be an extra- preservation method that reduces microorganisms and removes moisture from raw fish. Overfishing can cause spoilage of fish, which prompted the development of a preservation chamber to minimize the impact of decay [4].

Despite being a cultural practice, sun drying is not a reliable preservation method due to weather fluctuations, potentially leading to inconsistent end product quality [5]. Fish has a high moisture content, with water comprising around 80% of its weight. To reduce this moisture, dehydration chambers are used with drying temperatures typically ranging from 40°C to 80°C. A study [7] found that higher drying temperatures resulted in lower final moisture content.

The traditional method of fish drying was difficult due to the risk of contamination and unsafe handling practices [8]. To overcome these challenges, it is important to anticipate and address potential issues when building a drying chamber. This includes selecting safe materials and maintaining consistent quality to prevent mold and harmful microorganisms from growing [9]. In a study, hybrid drying was able to reduce fish moisture by approximately 30%, which is considered a satisfactory level of dryness [10].

Consistent high standards are crucial for dried fish, which is valued both locally and globally [11]. Compared to sun drying, the developed drying chamber offers a safer and more profitable means of producing dried fish suitable for human consumption [12]. Temperature and humidity are important factors that impact the drying process, and their optimization is essential for achieving rapid drying and improving weight loss [13]. Advanced systems are used in fish processing to ensure quality preservation and prolonged shelf life [14]. Fish dryers are practical tools that can enhance the fish quality [15]. Implementing drying chambers can improve fish quality [16].

METHODOLOGY

Figure 1 represents the block diagram of the drying chamber that will be powered by an AC power source. To measure the weight of the fish, a load cell sensor was incorporated with a microcontroller (ATmega328P), and the results will be displayed on a liquid crystal display. The thermostat regulates the temperature of the heating element, and a DC fan is used to distribute heat throughout the drying chamber.

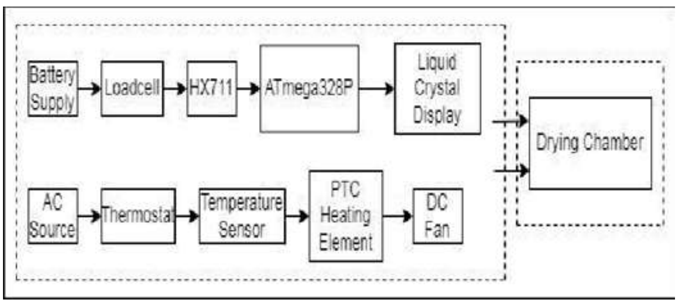

Figure 1: Block Diagram for Entire Drying Chamber

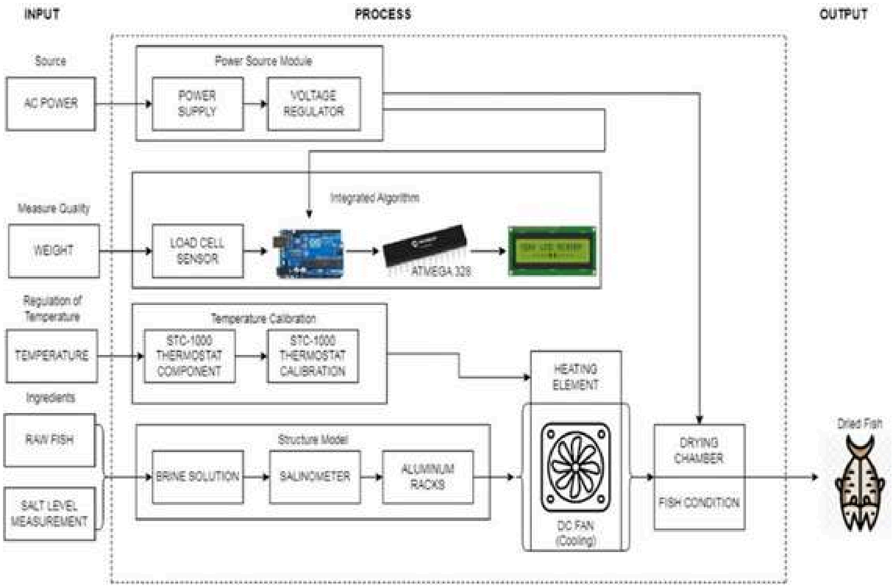

Figure 2: Conceptual Framework

Figure 2 shows a conceptual framework consisting of Input, Process, and Output components. The system needs an AC power source to function, which is the primary energy source chosen. Raw fish cured with salt or brine is the main ingredient. The process involves several steps, such as the Power Source Module, raw fish, salt level measurement, and temperature regulation system. A load cell connected to ATmega328P accurately measures the weight of the fish, which is displayed on an LCD. The drying chamber assesses the condition of the dried fish and production output.

The study used a Prototyping Design Model, as shown in Figure 3, to create the system. This methodology was effective in achieving the study's objectives. The model involves building a prototype, testing it, and making iterative changes until a satisfactory outcome is achieved, providing a basis for the final product or system's development.

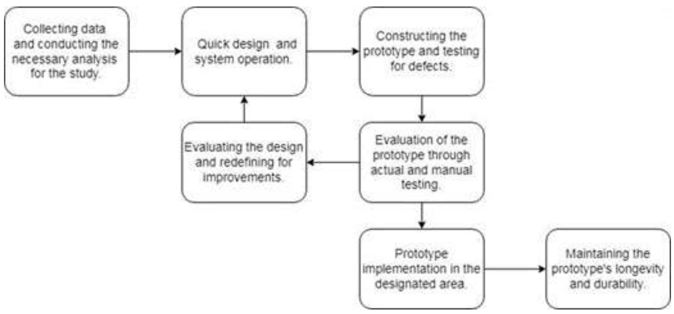

Figure 3: Prototyping Model

RESULTS AND DISCUSSION

A. Trials Results

The trial outcomes are presented below, where sample fish were weighed before and after the drying process to evaluate the system's functionality. The dried fish were then assessed based on the characteristics listed in Table 1. The efficiency of the system was compared to traditional drying methods, and accuracy testing was conducted, where the sample fish were dried in 6-8 hours, and the load cell accurately measured the weight before and after drying.

DRIED FISH QUALITY	CHARACTERISTICS OF DRIED FISH			
	TEXTURE	*APPEARANCE*	*SALTINESS*	*SMELL*
HIGH QUALITY	Firm texture and clean	Light brown colored and hard	Balanced saltiness	Good smell
MEDIUM QUALITY	Soft texture and clean	Brown colored	Slightly salty	A bit smelly
LOW QUALITY	Soft texture and has mold development	Deep brown colored	Strongly pungent	strong unpleasant odor

Table 1: Characteristics of Dried Fish

B. Validation of Results

Five out of the seven trials conducted for result validation were carried out with the beneficiaries of the capstone project, as depicted in Figure 4. The beneficiaries had experience in traditional sun drying methods and guided the drying process. The remaining two trials were conducted by engineering and system experts to evaluate the system's hardware components and internal and external design, respectively.

The evaluation of the system's design is crucial, especially as it is intended for implementation in a coastal area where external and internal factors may affect the system's condition. Figure 5 shows the evaluation process carried out by the system expert. It also includes the capstone adviser for evaluating the capstone paper, Michael Angelo D. Ligayo, D.T, and Engr. Leonard Catchillar is the technical expert.

Figure 4: Implementation of the System in Cavite

Figure 5: System Expert Evaluation

Types of Fish	Standard Temperature
Dilis	48 ℃
Sapsap	50 ℃
Bangus	60 ℃
Tilapia	65 ℃

Table 2: Standard Temperature for Drying

Table 2 shows that different fish types require varying drying temperatures for optimal results. Anchovies or "dilis" should be dried at approximately 48°C, while ponyfish or "sapsap" require a temperature of 50°C. For milkfish or "bangus," a slightly higher temperature of 60°C is recommended, while tilapia necessitates a temperature of around 65°C. These temperature discrepancies may significantly affect the dried fish's nutritional value and overall quality. Therefore, understanding the specific drying requirements for each type of fish is crucial in ensuring proper preservation and retention of quality during storage.

In the five (5) trials conducted, the standard and normal drying temperatures were determined based on the typical temperature range, yielding a high accuracy percentage. As shown in Figure 6, for all four types of fish, among the five trials, the 5th trial almost reached the standard temperature as shown in Table 2 for the Sapsap Fish got 49.6℃, Bangus with 58.3℃, and Tilapia with 60.0℃. While, Dilis reached 48.1℃ but, these 5 trials were used by the proponents since they generated a 96.56%, 95.06%, 90.68%, and 98.37% accuracy rating respectively.

Figure 6: Temperature Trials of Sample Fishes

D. Testing Results

The system scored a high functionality rating of 3.74, indicating that all components, including sensors, are operating properly. The efficiency rating, with an average of 3.78, is also excellent, demonstrating the successful execution of the fish drying procedure and programming. The accuracy rating, shown in Figure 7 for the dried fish sample trial, had an average score of 2.82 and a verbal interpretation of "High Quality," proving the reliability and capability of the drying chamber with its moisture and salinity meters. Table 3 displays the weight differences of the sample fish before and after the drying process, confirming its completion.

LOAD CELL SCALE				
FISH NO.	MEASURED IN GRAMS/KILOGRAMS		$MC = \frac{Wet\ weight - Dry\ weight}{Wet\ weight} x\ 100$	MOISTURE CONTENT
	Before Drying	*After Drying*		
1	91 grams	47 grams	$\frac{91-47}{91} x\ 100$	48.35%
2	77 grams	49 grams	$\frac{77-49}{77} x\ 100$	36.36%
3	69 grams	35 grams	$\frac{69-35}{69} x\ 100$	49.27%
4	83 grams	41 grams	$\frac{83-41}{83} x\ 100$	50.60%
5	64 grams	27 grams	$\frac{64-27}{64} x\ 100$	57.81%

Table 3: Moisture Content Percentage on a Load Cell Scale

Figure 7: Actual Result of the Sample Trial of Dried Fish

CONCLUSION AND FUTURE WORKS

The construction of a fish drying chamber can significantly improve the efficiency and effectiveness of fish drying. Investing in a well-designed and functional chamber can benefit both the fish industry and consumers. Accurately measuring salt levels can help determine the optimal brine solution for preserving fish as food. Additionally, using a load cell sensor to track fish moisture content during drying can provide valuable insights into the process's effectiveness.

The study's limitation is the restricted number of sensors available for measuring moisture directly. Future researchers are encouraged to address this limitation by using additional sensors to measure moisture levels. Nonetheless, the system presented in this study can successfully dehydrate fish and consistently produce dried fish of satisfactory quality and safety.

ACKNOWLEDGEMENT

The authors express their heartfelt appreciation to the Allosada Family, the primary benefactors, for their kindness and assistance during the testing phase. The authors also extend sincere gratitude to all individuals involved in the development of the system that promises to be of immense benefit to its users. Above all, the authors would like to acknowledge the Almighty God for enabling the accomplishment of all things.

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