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Utilization of IoT and biomass energy for innovation in cracker production

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ABSTRACT

This study explores an innovation based on IoT and biomass energy for the efficient production of processed food, specifically crackers. Biomass energy, derived from plant materials, is utilized to generate heat in the processing room. This innovation significantly reduces the processing time for crackers to just 2 hours, compared to the conventional method that requires 2 days of sun-drying. The biomass energy source used in this study includes rambutan tree trunks, which not only provide efficient heat but also impart a pleasant aroma to the final product. The research employs a direct experimental method to design and implement this technology in industrial settings. The primary ingredient for the crackers is cassava, mixed with fish, shrimp, and jengkol. The heat energy generated from the combustion of rambutan tree trunks is effectively utilized in the combustion chamber. Observations indicate that the crackers produced are of high quality, with appealing color and fragrance, making them suitable for market distribution. This innovation demonstrates the potential of combining IoT and biomass energy to enhance food processing efficiency and product quality.

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1. INTRODUCTION

Biomass is a plentiful energy resource derived from plant materials found on Earth. As the population of living beings continues to grow, the significance of biomass is expected to increase. This form of energy is vital for sustaining life, as it is a renewable source that does not deplete. Currently, efforts are underway to enhance the use of biomass for generating heat energy through various physical processes [1, 2].

The utilization of biomass energy involves various physical processes related to heat transfer, such as conduction, convection, and radiation. Using the radiation mechanism, heat energy generated from biomass is transferred to the combustion chamber. In addition, the convection mechanism heats the air within the chamber, which promotes airflow and further heating. On the other hand, during the conduction process, the metal walls of the device are capable of absorbing and retaining heat, facilitating heat transfer into the chamber designated for drying crackers [3, 4].

The engineering approach utilized in this cracker processing tool incorporates zinc plates, which facilitate a multiple reflection system. This design enhances heat retention within the chamber,

thereby reducing the amount of biomass required. The configuration for utilizing biomass waste as an energy source involves two drums positioned on either side of the device, optimizing heat transfer to the drying chamber and consequently decreasing reliance on coconut shells as a fuel source [5, 6]. Additionally, this technology features an internet of things (IoT) system that enables real-time monitoring of temperature fluctuations and moisture levels in the drying materials.

The method used in this research is the experimental method, meaning that the engineering design of the technology tool was developed first, followed by testing this technology in the industry for processing cracker foods. The quality of the produced crackers is indicated by a low moisture content, with moisture data reaching 0 percent. The color of the crackers is very bright, and the aroma of the ingredients remains prominent, such as the flavors of jengkol and shrimp. This indicates that the engineering design has been successful and has effectively produced a quality cracker product [7-9].

The IoT has become a key driver in the transformation of industries, including agriculture and food production. By connecting various devices through the internet, IoT enables real-time data collection and analysis, which can enhance efficiency and productivity in production processes. In the context of cracker production, the use of IoT technology can assist in monitoring the quality of raw materials, regulating temperature and humidity during processing, and automating machine monitoring. This not only reduces the risk of human error but also speeds up production time and improves the quality of the final product.

Moreover, the utilization of IoT in cracker production allows for the implementation of sustainable practices. By leveraging sensors and smart devices, producers can monitor energy use and other resources, optimizing consumption and reducing waste. The integration of IoT with biomass energy as a renewable energy source provides opportunities to produce crackers with a lower carbon footprint. Thus, this innovation not only supports operational efficiency but also contributes to environmental sustainability and the local economy.

2. RESEARCH METHODS

The materials utilized in this study primarily consist of raw ingredients sourced for cracker production. These ingredients are procured from local communities that specialize in the cultivation and processing of cracker components, ensuring a sustainable supply chain that supports local economies. By collaborating with these communities, the study not only promotes the use of fresh and quality raw materials but also fosters local agricultural practices. This approach enhances the flavor and nutritional value of the crackers while contributing to the livelihoods of local farmers.

For the engineering design of the technological innovation tool, several materials are strategically chosen to optimize performance and efficiency. Zinc plates are employed for their durability, while drums are utilized for effective fuel storage. To ensure proper insulation, 4 mm thick plywood is incorporated into the design. The structural frame is constructed from particle board, providing a solid foundation. Additionally, drying racks and a chimney are integrated to facilitate smoke disposal and regulate airflow within the drying chamber. An IoT monitoring system plays a crucial role in this setup by continuously tracking room temperature and moisture content changes in the processed cracker materials, thus ensuring optimal drying conditions and product quality.

Figure 1. Design of the research equipment.

Figure 1 illustrates the design of the research equipment used in the cracker production process, showcasing the integrated components essential for efficient operation. The diagram features a robust framework constructed from particle board, supporting various elements such as drying racks and a chimney for effective smoke management and airflow regulation. Zinc plates are strategically placed to enhance durability, while drums are incorporated for secure fuel storage. Additionally, the design includes an IoT monitoring system that tracks temperature and moisture levels, ensuring optimal conditions for drying the cracker materials. This comprehensive design not only facilitates efficient production but also emphasizes sustainability and quality control in the manufacturing process [10].

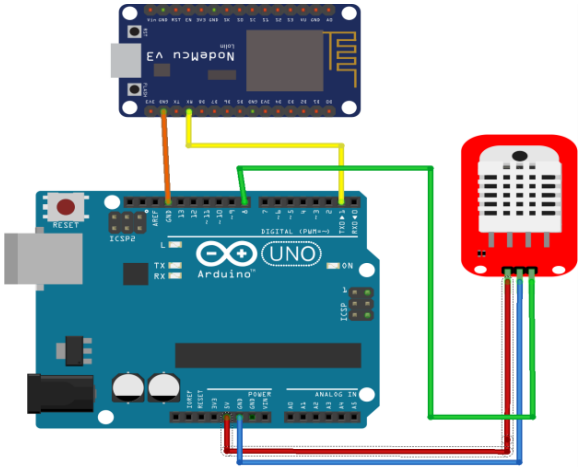

Figure 2. IoT device circuit.

Figure 2 illustrates the IoT device circuit used in the cracker production process, designed to monitor and control essential parameters in real-time. In this system, temperature and humidity sensors are installed within the drying chamber, allowing for accurate data collection regarding the environmental conditions surrounding the cracker materials. The collected data is then transmitted to a mobile application, enabling users to monitor and adjust the drying process remotely. With this system in place, producers can make necessary adjustments to ensure the quality of the final product and energy efficiency, while also reducing the risk of damage to the materials during processing. This device circuit not only enhances productivity but also supports more sustainable production practices.

3. RESULTS AND DISCUSSIONS

The technology for processing raw materials for crackers is an important innovation to enhance the productivity and quality of good crackers. The final productivity in cracker production depends on the technology used. The engineering design process for creating the cracker processing technology tool can be seen in Figure 3.

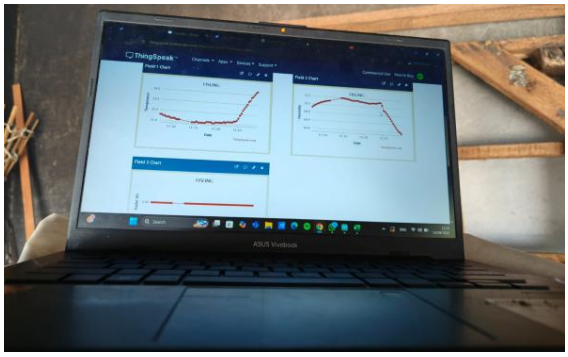

Figure 3. Engineering design process for creating innovative technology tools for cracker processing with IoT .

Figure 3 showcases the engineering design process for developing innovative technology tools aimed at enhancing cracker processing through an IoT system. This image highlights the interface of the monitoring system, displaying real-time data analytics related to temperature and humidity levels during the production process. By incorporating advanced technology, producers can gain valuable insights into the drying conditions of the cracker materials, which directly influence the final product's quality. The ability to visualize these parameters on a user-friendly platform facilitates informed decision-making, ensuring optimal processing conditions.

In addition to improving productivity, the engineering design process illustrated in Figure 2 emphasizes the integration of IoT technology into traditional production methods. This approach not only streamlines operations but also enhances the overall efficiency of the cracker manufacturing process. Through continuous monitoring and data analysis, producers can swiftly identify any anomalies or areas needing adjustment, thereby minimizing waste and improving resource management. Ultimately, this innovative design represents a significant advancement in the field, promoting higher standards of quality and sustainability in cracker production.

Furthermore, the engineering design aims to increase the efficiency of the tool so that heat does not escape from the combustion furnace. Therefore, the tool is designed with a rack system for placing the crackers that will be dried. The purpose is to facilitate heat distribution to the materials being dried, as can be seen in Figure 4.

Figure 4. Engineering the creation of racks for placing the raw materials of crackers to be dried.

Figure 4 depicts the engineering process involved in creating drying racks specifically designed for placing raw cracker materials. The image shows an individual actively using the drying rack, which highlights the practical application of this essential tool in the production process. The racks are engineered to optimize airflow and maximize exposure to heat, ensuring that the cracker materials dry evenly and efficiently. This design is critical for maintaining the quality of the final product, as proper drying prevents issues such as mold growth and inconsistent texture.

Moreover, the construction of these racks reflects a thoughtful consideration of both functionality and accessibility. The design allows for easy loading and unloading of the raw materials, facilitating a smooth workflow in the production area. By utilizing durable materials and an ergonomic structure, the racks enhance the overall efficiency of the drying process. This image serves as a testament to the importance of innovative engineering solutions in traditional food production, demonstrating how such advancements can lead to improved product quality and increased productivity in the cracker manufacturing industry.

The Figure 5 illustrates the variation in water content of 1000g of tubers over time. The data presented shows a decrease in water content from 30% at the first minute to 11% at the 40th minute. This decline indicates that as time progresses, the tubers lose moisture, which could be attributed to the drying process. Understanding this is crucial in the context of storage and processing of tubers, where the right moisture level significantly affects the quality and shelf life of the product. Furthermore, this graph provides insights into how time influences food quality. The significant decrease in water content over a relatively short period can impact storage and processing methods.

For instance, farmers or producers of tubers should pay attention to harvest timing and storage to maintain optimal water levels, preventing spoilage and preserving freshness. By understanding the relationship between time and water content, steps can be taken to enhance the quality of the final product.

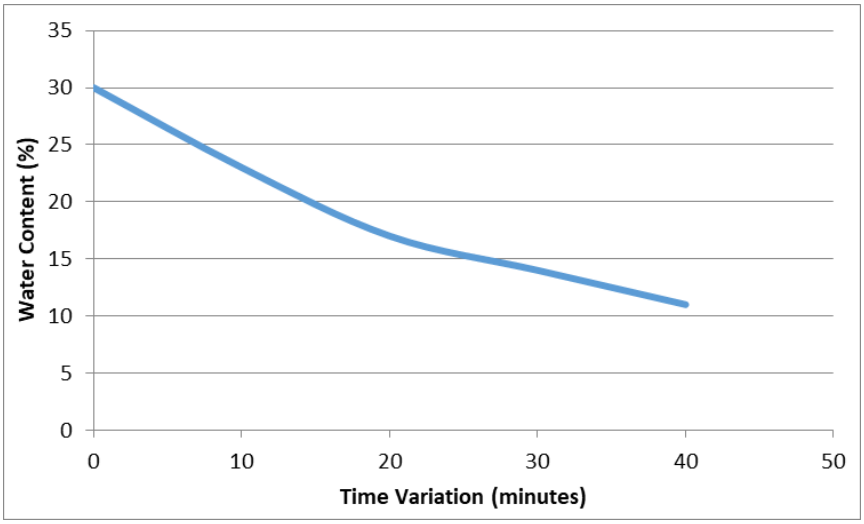

Figure 5. Changes in water content in cracker products using 1000 grams of biomass.

4. CONCLUSION

The integration of IoT technology in the cracker production process significantly enhances operational efficiency by enabling real-time monitoring of critical parameters such as temperature and humidity, which directly influence product quality. The innovative engineering design of the cracker processing tool, including the use of drying racks and optimized heat distribution systems, effectively reduces moisture content in the final product, ensuring high quality and improved shelf life. By sourcing raw materials from local communities, this research not only supports sustainable agricultural practices but also fosters the local economy, demonstrating the potential of combining modern technology with traditional production methods for enhanced food quality and sustainability.

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