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Design and Development of a 5 kg Capacity Cracker Dough Mixer

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Abstract

This research developed a 5 kg cracker dough mixer designed to meet the needs of small to medium scale production. The single-phase motor used is adapted to the needs of small to medium-sized businesses in order to achieve optimal energy efficiency. The simple control panel, which includes an on/off switch and emergency stop button, is ergonomically designed for easy operation by non-technical operators. The cleaning process of the machine is also made easy with a stirrer housing that can be opened or tilted, supporting hygiene and speeding up work. This design emphasizes efficiency, safety, and comfort of use. This research is expected to advance food machinery technology, especially in cracker processing, and become a reference for the development of similar machines in the future.

Keywords: *mixing machine; cracker dough; 5 kg capacity; stainless steel; food processing machine technology.*

Abstrak

This research developed a 5 kg cracker dough mixer designed to meet the needs of small to medium scale production. The single-phase motor used is adapted to the needs of small to medium-sized businesses in order to achieve optimal energy efficiency. The simple control panel, which includes an on/off switch and emergency stop button, is ergonomically designed for easy operation by non-technical operators. The cleaning process of the machine is also made easy with a stirrer housing that can be opened or tilted, supporting hygiene and speeding up work. This design emphasizes efficiency, safety, and comfort of use. This research is expected to advance food machinery technology, especially in cracker processing, and become a reference for the development of similar machines in the future.

Kata kunci: Mesin Pengaduk; Adonan Kerupuk; Kapasitas 5 Kg, *Stainless Steel*; Teknologi Mesin Pengolahan Makanan

1. Introduction

Indonesia's snack food industry, particularly cracker production, continues to expand due to increasing market demand **[1,2].** Over the past five years, the trend of cracker-based food, specifically "Seblak," a characteristic West Javanese dish, has significantly boosted the local economy and attracted millennials to regional cuisine. This "Seblak" food trend has consequently elevated cracker demand, leading to an increase in the number of businesses supplying these products. Cracker production involves several stages: mixing, printing, steaming, drying, and frying **[3,4,5].** The quality of cracker dough depends on various factors, including optimal composition, accurate measurement of ingredient proportions, thorough mixing, and correct procedural execution **[6,7,8].** One crucial step in cracker production is dough mixing, which plays a significant role in determining the final product's texture and quality **[9,10,11].** However, in micro, small, and medium-sized enterprises (MSMEs), dough mixing is still largely performed manually **[12,13].** This presents a major challenge as manual methods are not only time and labor-intensive but also result in inconsistent product quality depending on the individual preparing the dough, ultimately affecting product consistency and limiting the capacity for significant production increases **[14,15,16].** Cracker dough preparation involves mixing ingredients such as tapioca flour, wheat flour, water, and other additives like garlic, salt, sugar, flavor enhancers, and baking powder to impart flavor, aroma, and aid in cracker expansion during frying **[17].**

Based on the existing challenges, several innovations have emerged to address these issues. Some manufacturers have developed dough mixing machines for large-scale industrial needs, featuring high capacities and advanced automation systems. Conversely, some innovations involve small workshops creating basic dough mixer designs primarily for bread making, utilizing electric motors and fundamental mixing systems.

A significant gap in previous research is the development of a dough mixer specifically designed for cracker dough with a small-to-medium capacity (around 5 kg), featuring an ergonomic, efficient, and affordable design. This potential remains largely untapped, despite the high demand for such equipment among MSMEs. To address this void, this research proposes a design concept for a 5 kg capacity cracker dough mixer that prioritizes work efficiency, operational ease, consistent dough quality standards, and low production costs. The machine utilizes an electric motor as the primary drive, a simple transmission system, and a stainless-steel

mixing bowl to maintain hygiene and food safety. A hollow steel frame is integrated to minimize production costs without compromising the machine's strength and stability.

2. Method

The development process for the cracker dough mixer commenced with data collection through observation, interviews, and literature reviews to ascertain user requirements and technical references. This information was utilized to create initial design sketches, which were then further developed by selecting appropriate materials based on functionality and durability. Subsequently, the technical design of the machine was finalized, followed by a structural strength analysis using stress analysis with CAD (Computer-Aided Design) software. This analysis aimed to identify areas experiencing high stress, deformation, or potential structural failure. The simulation results aided in evaluating whether the design was sufficiently robust and safe, or if improvements and optimizations were required before the manufacturing process began. The process then proceeded to the manufacturing phase with continuous monitoring to ensure adherence to the design specifications. The completed machine underwent performance evaluation, and if it met the established standards, it was deemed ready for use. This systematic approach ensured that all issues, from technical aspects to functional performance, were resolved in a phased and structured manner. The research stages are presented in Figure 1.

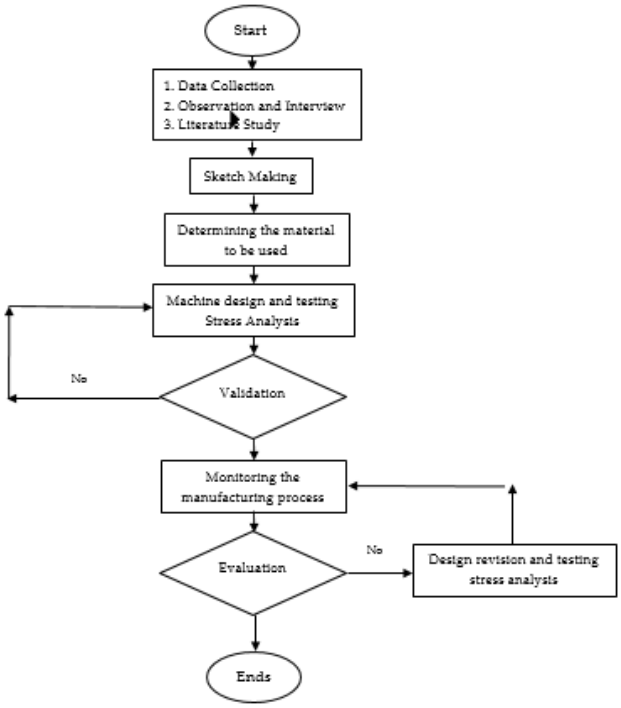

Figure 1. Research Stages

The novelty offered in this research lies in its material combination, utilizing stainless steel for food-contact components and lightweight or hollow steel for the main frame. Furthermore, the single-phase motor is specifically tailored to meet the needs of small and medium-sized enterprises. Several design aspects of the mixer blades, featuring a dual-blade configuration, aim to enhance dough homogeneity in a shorter processing time and ensure more user-friendly machine operation, particularly for non-technical operators. The control panel is designed for simplicity, incorporating only an on/off switch and an emergency stop button placed in an easily accessible position, making the tool's operation intuitive and safe. From an ergonomic perspective, the machine's height is adjusted for comfortable standing work posture to minimize fatigue during prolonged use. Additionally, the cleaning process is simplified by a mixing bowl design that allows for tilting or opening, enabling effortless removal of residual dough. All parts in direct contact with food materials are easily accessible for cleaning, thereby maintaining hygiene and expediting the workflow.

3. Results

The 5 kg capacity cracker dough mixer is designed to meet the needs of household to medium-scale industries, with a focus on efficiency, ease of operation, and homogeneity of the mixed product. The design results include the following technical specifications: machine specifications are presented in **Table 1.**

Tabel 1. The specifications of Cracker Dough Mixer Machine

No	Component	Specifications
1	Maximum Capacity	5 kg of wet dough
2	Drive Motor	1 phase electric motor, 220V AC, 1200 rpm
3	Mixing System	Horizontal double mixer (*horizontal mixer*)
4	Container Dimension	Ø 410 mm, height 300 mm (food grade stainless steel material)
5	Transmission System	Pulley and V-belt
6	Mixing Rotation Speed	± 40 rpm (the result of transmission reduction)
7	Drive System	Motor directly turns to the mixer shaft via pulley
8	Frame Material	Hollow steel 40x40 mm

The functional design represents the initial phase in the machine design process, aiming to define both the primary and supporting functions of the system under development. At this stage, the cracker dough mixer is designed to efficiently and homogeneously mix raw cracker ingredients, such as tapioca flour, water, and seasonings. The machine's main function is to mechanically mix the dough, replacing manual methods that are labor-intensive and time-consuming. The mixer must be capable of uniformly blending high-viscosity dough within a relatively short period, without compromising the dough's texture or reducing its quality, ensuring consistency with manual mixing processes. The functional design is presented in **Table 2.**

Table 2. The functional Design of Cracker Dough Mixer Machine

No	Main function	Subfunction	Purpose	Description
1	Stirring cracker dough	Rotating the stirrer	Stirring the dough until it is evenly mixed	Driving the motor at a constant speed
2	Holding the dough	Mixer container	Holding dough up to 5 kg	Made of stainless steel
3	Keeping the machine clean	Easy to clean.	Simplifying maintenance and the hygiene	The mixer container that can be opened or tilted
4	Ensuring operational safety	Easy to operate with an on/off button.	Preventing accidents while the machine is running.	Equipped with an emergency button.
5	Providing a power source.	Electrical system.	Providing electrical power for the motor	Motor voltage and power meet the standards.

The structural design is the phase that focuses on determining and arranging the machine's physical elements comprehensively, including dimensions, materials, form, and the layout of key components. The objective of structural design is to ensure that the machine not only functions as required but is also robust, safe, and ergonomic in operation. The structural design is presented in **Table 3.**

Table 3. The Structural Design of Cracker Dough Mixer Machine

No	Component	Description	Function	Main Material	Remarks
1	Electric motor	Single-phase AC electric motor	Driving the mixer shaft	Steel, copper (winding)	Single-phase electric motor
2	Mixer shaft:	Steel shaft connected to the motor	Transmitting rotation to the mixer	Stainless steel	Stainless steel shaft
3	Mixer blade	Curved blade attached to the shaft	Stirring the dough until it is evenly mixed	Stainless steel	Horizontal double mixing blades
4	Mixer container:	Cylindrical container with an additional tube on top	Dough container	Stainless steel	Rust-resistant, easy to clean
5	Machine frame	Motor and container support structure	Supports all machine components	Hollow steel	Sturdy with 850 mm high
6	Control panel:	on/off and emergency stop buttons	Controls machine operation	Plastic and electronics	Assembled in a panel box
7	Electrical system:	Cables, switches, and connecting cables	Distributing electrical power to the motor and controls	Copper, plastic cables	Complying with electrical safety standards

The design outcomes for the 5 kg capacity cracker dough mixer represent the final stage of the engineering process, following thorough needs identification, functional analysis, and structural and mechanical planning. The resulting machine design is presented in **Figure 2.**

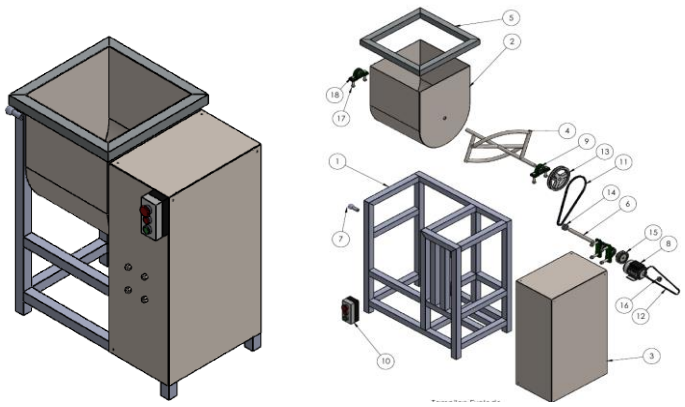

Figure 2. The result of Designing a Cracker Dough Mixer Machine

4. Conclusion

This research contributes to the advancement of cracker dough mixing technology through a medium-capacity design. The 5 kg capacity cracker dough mixer has been meticulously designed with both functional and structural aspects in mind, aiming to meet the production demands of small to medium-scale enterprises. This machine design intelligently combines stainless steel for all food-contact surfaces with lightweight or hollow steel for the main frame, ensuring structural integrity and suitability for its intended purpose. The use of a single-phase motor is tailored to the requirements of small and medium businesses, providing optimal energy efficiency. The mixer's dual-blade design significantly enhances dough homogeneity within a short processing time. Furthermore, the simple control panel, featuring an on/off switch and an emergency stop button, is ergonomically designed for intuitive operation, especially for non-technical users. Cleaning is also simplified by a mixing bowl design that allows for tilting or opening, ensuring hygiene and expediting the workflow. Overall, this design prioritizes efficiency, safety, and user convenience in machine operation. Consequently, this work advances knowledge in the field of food processing machine technology, particularly for cracker production, and can serve as a valuable reference for the development of similar machines in the future.

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