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Sago Cake Mold Machine Capacity 45 Kg/Hour Frame and Material Selection

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A B S T R A C T

This research aims to design and make a sago cake dough molding machine to help small industries in Banjarmasin that still rely on manual processes in their production. So far, dough molding has been done traditionally using simple tools, so it takes a long time, a lot of labor, and a lot of workers. The main problem lies in the limited production capacity due to the inefficient printing process. The design process starts from making working drawings, followed by material selection, cutting, drilling, welding, to painting components, especially screws. This engine is designed using a 0.5 HP electric motor with a speed of 1400 rpm, equipped with a 1:4 ratio gearbox and a V-belt transmission system type A52. The drive shaft uses ST37 material with a diameter of 28 mm, while the main frame is made of 30x30x3 mm elbow iron. With this design, it is hoped that the production of sago cakes will be faster, more efficient, and more labor-efficient.

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INTRODUCTION

Sago is a flour or processed obtained from the processing of the core of saffron stems or "sago trees" (Mettroxylon sago Rottb). Sago flour has similar physical characteristics to tapioca flour. Sago is a staple food for the people of Maluku and Papua who live on the coast (*Sago - Wikipedia, Indonesian, the free encyclopedia*, n.d.).

Saju flour is the main ingredient for making sago cake, the texture of this cake will melt by itself in the mouth. This soft-textured cookie is usually the prima donna of Eid cakes. Sago cake is made from a mixture of sago flour, powdered sugar, grated cheese, margarine, egg yolk, Salted Butter, thick coconut milk. The dough of the ingredients is then molded and arranged in a baking dish to then bake for 30 minutes or until golden crisp.

The production of sago cakes is usually made traditionally so that it takes time to process, this is because it still uses conventional molds. This method is considered quite draining and has an impact on the limited amount of production. Meanwhile, manufacturers must produce in large quantities to meet market demand with the minimum possible time. The risk of traditional work will also arise if workers are not present in making the cake. In making sago cakes, producers usually divide the work into two parts, one of the workers in the printing department and another worker in the oven department so that if one of the workers is not present, the production of sago cake will also be constrained.

After knowing the problems that exist in the production of making sago cakes, it is necessary to have a tool to make it easier for producers to produce this cake. The tool is in the form of a cake printing machine with a semi-automatic system. This machine is aimed at SMEs (Small and Medium Enterprises)

Home industries engaged in the production of sago cakes to increase production results, shorten printing time and maintain the quality of cake production products so as to increase market competitiveness.

LITERATURE REVIEW

The manual production processes used in small sago cake processing industries in regions like Banjarmasin significantly hinder efficiency and productivity. Due to the heavy reliance on human labor, production capacities remain low, leading to inconsistent product shapes, which directly impacts product quality and market competitiveness (Abidin et al., 2020; Asriani, 2021). Labor fatigue is heightened during these intensive manual processes, especially as demand rises. This issue is compounded by the challenges presented by sago, which, despite its high calorific value and use in various food products, often requires improved processing techniques to optimize its properties for better quality outcomes (Santoso et al., 2020). Adoption of modern technologies and methodologies in processing, such as HACCP for quality management, can enhance productivity and consistency in products, addressing the significant production challenges faced by these small-scale industries (Căpruciu & Lazar, 2023).

The design of dough molding machines necessitates careful consideration of materials to ensure mechanical reliability, durability, and compliance with food safety standards. ST37 steel is a prevalent choice for shafts and frames in small-scale machines due to its favorable mechanical properties, ease of fabrication, and cost-effectiveness (Asriani, 2021). Its resistance to torsional loads and vibrations renders ST37 particularly suitable for applications where consistent performance during molding processes is essential (Abidin et al., 2020). Additionally, the utilization of 30x30x3 mm angle iron for the frame further enhances structural stability. This geometric configuration contributes to robust assembly, allowing the frame to withstand operational stresses effectively (Santoso et al., 2020). The interplay of these material choices not only assures strength and longevity but also aligns with safety requirements in food machinery design, promoting both functional efficacy and user confidence (Căpruciu & Lazar, 2023).

The drive system is indeed a critical component in the design of dough molding machines, particularly in small-scale industries where efficiency and reliability are paramount. The choice of a 0.5 HP electric motor operating at 1400 rpm serves as an effective solution, as it offers sufficient power for operating the molding screw at moderate production speeds while ensuring energy efficiency. This power specification is well-suited to handle dough with varying viscosities, which is a common challenge in such applications.

Employing a gearbox with a 1:4 reduction ratio optimally reduces speed while significantly enhancing torque, making it suitable for processing dough with higher viscosity (Santoso et al., 2020). This configuration facilitates smoother operation and helps prevent motor overload during production. Furthermore, the use of an A52 type V-belt in the transmission system has been documented for its stable power transfer and low maintenance requirements, adding to the reliability of the overall drive system (Căpruciu & Lazar, 2023).

Furthermore, employing an A52 type V-belt transmission system offers several advantages for simple machinery. Known for its efficiency and ease of maintenance, the V-belt system provides reliable power transmission and minimizes slippage, thus contributing to consistent machine operation. The combination of these mechanical components ensures that the small-scale dough molding machines operate effectively while maintaining ease of maintenance, which is critical in small production settings.

METHODOLOGY

This study employs an engineering design method using a systematic engineering approach consisting of several key stages at figure 1.

Figure 1. Research Stages

Problem Identification

The initial step involves field observation of small-scale sago cookie industries in Banjarmasin. The main issue identified is the manual dough shaping process, which is time-consuming, labor-intensive, and requires many workers, resulting in low production capacity.

Preliminary Design

Based on the identified problem, a preliminary machine design was created. This stage includes the development of technical drawings or blueprints, which serve as references for the machine fabrication process.

Material and Component Selection

Once the design is complete, the next step is selecting appropriate materials and machine components. The selection is based on criteria such as mechanical strength, durability, cost-effectiveness, and local availability.

Manufacturing Process

This phase covers the fabrication of machine parts, including cutting, drilling, welding, and assembling. Tools and equipment used include welding machines, drilling machines, lathes, and grinders.

Machine Assembly

After all components are fabricated, the machine is assembled into a complete unit ready for operation.

Testing and Evaluation

The assembled machine undergoes testing to assess its performance, production efficiency, and dough output capacity. Evaluation focuses on whether the machine meets the target capacity of 45 kg/hour and whether further design improvements are needed.

RESEARCH RESULT

The design of this sago cake printing machine follows the design of the existing printing machine, this sago cake printing machine is driven by a 1/4 HP electric motor, but the capacity of the machine adjusts to the sago cake trader industry in Banjarmasin.

The materials used in the process of making an automatic young coconut peeler are:

Elbow Iron

In the process of making this automatic young coconut peeling machine, 3 x 3 pieces of elbow iron with a size of 3 x 3 and a length of 6 meters with a thickness of 4 mm are used as a foundation and frame.

Shaft Iron

The iron shaft used is 55 cm in size and 1 inch in diameter to pass the rotation of power from the electric motor to the shaft of the coconut cutting table

Plate

In the process of making this automatic young coconut peeling machine, it uses a Gray Iron plate with a width of 200 cm and a length of 100 cm which is used as an iron extruder and dough input

Bolts and Nuts

Bolts and nuts are as fasteners of the components of the automatic young coconut peeling machine so that it is easy to change in the process of changing if it is damaged

Bearing Duduk

In the manufacture of this automatic young coconut peeling machine, bearings are used as a base for 2 shafts with a diameter of 42 mm and a shaft hole of 20 mm.

Pulley dan v belt

The pully used in the manufacture of this machine uses a pully with a diameter of 3 in, and 14 in. Using the V-belt A-52, it functions as a power conductor from the drive motor so that it can move the table and move the blade

Electric Motor

Considering that the industrial target of making this machine is the home industry, here we use a machine with power that is easy to use in the home industry, namely 1/4 HP and 220 V.

Gear box

Transmission gearbox is to change the speed and torque of the vehicle according to various road conditions and loads, the main function of the transmission (gearbox).

Iron Lime

When cutting iron, it is also usually difficult for you to mark the part to be cut, because iron or other metal materials cannot be marked with a pen or pencil

The process of designing the frame of the sago cake dough molding machine is carried out systematically by considering aspects of structural strength, mechanical stability, and efficiency in the fabrication process. The frame is the main component that functions as a support for all parts of the machine, so it must have the ability to withstand static and dynamic loads during the molding process (Halim et al., 2025; Ramadhani & Marno, 2023). The frame is designed using an angle iron material measuring 30x30x3 mm, with consideration of the ease of cutting, welding, and joining processes, as well as mechanical strength characteristics that suit the needs of the machine's workload. The design results show that the dimensions and configuration of the frame used are able to provide good stability and do not experience deformation during machine operation.

The selection of materials for each engine component is also carried out selectively. The drive shaft is made of ST37 carbon steel because this material has good mechanical properties, such as a fairly high tensile strength and toughness to torsional loads that occur during the system working. The ST37 is also easy to turn, weld, and shape, making it perfect for small-to-medium-scale manufacturing processes. The use of this material is proven to provide stable performance during engine testing.

In terms of the drive system, this engine uses a 1/4 HP electric motor with a rotation speed of 1400 rpm. This motor was chosen because the power generated is sufficient to drive the printer screws and meet the expected production capacity, while remaining efficient in energy consumption. To adjust the torque and output speed, a gearbox with a ratio ratio of 1:4 is used (S.-H. Kim, 2017; Sari & Nurhasanah, 2019). The transmission system uses an A52 type V-belt that connects the motor shaft to the gearbox. The use of this transmission is considered effective because it is easy to maintain, does not require lubrication, and can dampen vibrations.

This printing machine is designed with a production capacity of about 45 kg/hour, which is based on the average production needs of the small industry of sago cakes in the Banjarmasin area. The machine is designed to not only increase production capacity, but also reduce the use of manual labor significantly. The results of the initial tests showed that the machine was able to mold dough continuously with a uniform shape and a stable process speed. During the test, no significant obstacles were found such as jams in the printing system or frame instability, indicating that the design and selection of materials were in accordance with the technical and operational needs of the machine.

In this study, the vibration results will be compared with the ISO-10816 Vibration Severity Chart standard so that the condition of the V-belt transmission system used can be known. Based on the standard, the RMS vibration velocity value in the aligned position (0 cm misalignment) indicates that the test bed falls under the Class I category, and is in "good" condition for input speeds of 300 rpm and 600 rpm. Meanwhile, at the input speed of 900 rpm and 1200 rpm, the system falls into the "satisfactory" category. These results indicate that the V-belt transmission system has vibration performance that is still within safe and operational-grade limits. In addition, the results also reinforce the conclusion that the transmission assembly and tuning have been carried out precisely, so that the engine is able to work stably without causing excessive vibration that can damage components or reduce the working efficiency of the engine.

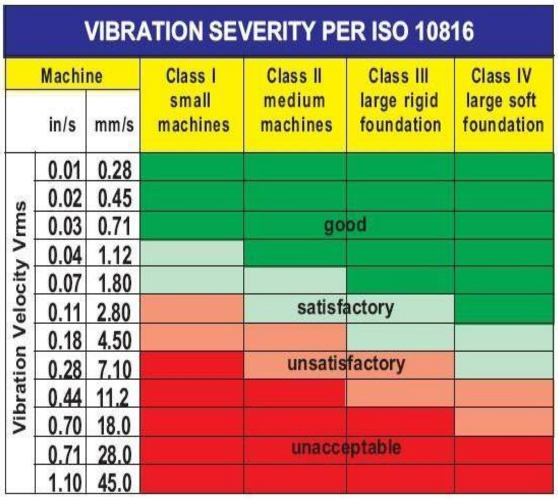

Figure 2. Tabel Vibration Severity

The process of designing the frame and selecting materials is an important stage in the development of a sago cake molding machine because it determines the structural strength and suitability of the material to the function and working conditions of the machine. The selection of machine elements is determined based on the material needs that suit the design, the strength required, and the availability of materials in the field. The stages in this process are described as follows:

Identify Work Drawings

The first step in making the frame is the identification of the working drawing, which is the basis for the visualization of the design of the machine table frame made of elbow iron. The working drawings are compiled by the designer and contain important information about the shapes, dimensions, and components to be made. The identification of working drawings aims to ensure the suitability of perception between the designer and the technical implementer, as well as to avoid errors in the fabrication process. Therefore, the working drawings must be clear and complete, including technical symbols and necessary process instructions.

Material Selection Process

The selection of materials is made based on references from the specification table available at the engineering materials provider. Since the working drawings only list the size or dimensions without material strength specifications, the matching is done by comparing the dimensions on the working drawings with the material data available in the material store. This method was chosen because there is no laboratory material test, so the accuracy of material selection is highly dependent on the accuracy of drawings and the experience of technicians in adapting the needs of the structure to the characteristics of the material.

Preparation of Work Steps Plan

Once the materials and working drawings have been identified, the next stage is to draw up a work step plan. This plan includes the sequence of the frame manufacturing process, including the type of work performed, the equipment and machinery used, and the estimated time of work. The preparation of work steps helps ensure that each stage of the process runs according to procedures and time targets and supports the achievement of accurate results according to the initial design. This stage also facilitates coordination between workers during the machine assembly process.

DISCUSSION

The results of the design and manufacture of the sago cake dough molding machine show that the use of a frame made of 30x30x3 mm elbow iron provides sufficient strength and stability to support all machine components. This is in accordance with the theory of machine structure design which emphasizes the importance of selecting materials with sufficient tensile strength, easy to form, and economically available in the local market (Haikal, 2025; Rahmad, 2019). The use of ST37 material for drive shafts is also considered appropriate because it has resistance to twisting and vibration loads that are common in small-scale mechanical transmission systems.

Material selection made based on reference tables from material providers, although not through laboratory testing, has proven to be quite effective in meeting design needs. This confirms that on a small industrial scale, a practical approach through field technical reference can still produce a product with good performance, as long as the working drawings are compiled in detail and accurately.

From the vibration test results, it is known that the V-belt transmission system used has an RMS vibration speed value that is still within safe limits according to the ISO-10816 Vibration Severity Chart standard. For input speeds of 300 rpm and 600 rpm, the engine condition is in the "good" category, while for 900 rpm and 1200 rpm it is in "satisfactory" condition. This shows that the transmission installation and tuning have been done properly, and there are no significant imbalances in the transmission system that could interfere with engine performance (Carvill & Cullum, 1994). The conformity between the vibration results and ISO standards also shows that the construction design and material selection meet not only the mechanical aspect, but also the dynamic aspect of the system.

The work step plan prepared before the manufacturing process has been proven to facilitate the efficient production process of the machine. Prior knowledge of the stages of work, the tools used, and the duration of the work help technicians in working systematically and avoiding mistakes. This reinforces the importance of clear technical documentation, from the identification of the working drawings to the assembly stages (Hasanuddin, 2020).

Overall, the results of this study show that the design of a sago cake dough molding machine with a simple but systematic engineering approach can produce a machine that not only meets the needs of small industry players, but also meets reliable performance standards. This is proof that the application of appropriate technology can increase the production efficiency of food MSMEs without having to rely on large-scale industrial equipment.

CONCLUSIONS AND RECOMMENDATIONS

This research successfully designed and built a sago cake dough printing machine with a production capacity of 45 kg/hour suitable for the needs of small industries in Banjarmasin. The machine frame made of 30x30x3 mm elbow iron and the drive shaft of ST37 steel show stable structural performance and resistance to workloads. The transmission system that uses a 1/4 HP electric motor, a 1:4 ratio gearbox, and a V-belt type A52 is able to drive the engine efficiently, with a vibration level that is still in the safe category according to ISO 10816 standards.

In addition, the approach in the identification of working drawings, the selection of materials through table references, and the systematic preparation of work steps have been proven to support an effective and on-target assembly process. The test results show that the machine can operate stably, with minimal vibration, and produce uniform dough molds, so it can be an appropriate solution to increase productivity and labor efficiency in micro and small businesses. To improve the accuracy of material selection, it is recommended that in follow-up studies a tensile test or hardness test be carried out on the main material, to ensure that the strength of the material is completely in accordance with the needs of the machine's workload. Although the vibration results are within safe limits, it is recommended to add a simple damping system such as a rubber pad or shock absorber to the engine legs to improve operational comfort and reduce component wear in the long run.

ADVANCED RESEARCH

For further research, it is recommended that further tests be carried out on engine performance over a longer operational period to determine component durability, energy efficiency, and potential wear of the transmission system. In addition, it is necessary to add an analysis of ergonomic aspects and work safety for users, as well as quantitative quality tests of dough molds. The development of microcontroller-based automation or control systems can also be the focus of advanced research to improve the precision and working efficiency of the machine, so that these machines are not only effective, but also able to compete on a wider industrial scale.

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