Design of A Combination Grilling Model of Sam-Sam and Chicken

Anak Agung Ngurah Bagus Mulawarman[1], I Ketut Gde Juli Suarbawa[2], and I Gede Oka Pujihadi[3]

[1,2,3] Mechanical Engineering Department, Politeknik Negeri Bali, Bali, Indonesia
julisuarbawa@pnb.ac.id

Abstract. The grilling tools commonly used today rely on square-shaped wire clamps to hold fish or chicken, placed over a combustion chamber with manual fanning, often resulting in uneven cooking or charring due to the proximity to the heat source. Additionally, manual fanning requires significant effort and time. This study designs an ergonomic grilling tool that integrates a wiper motor as the primary driver, using sprocket teeth and a chain to transmit motion, enabling continuous rotation of the food being grilled. The grill is versatile, capable of cooking not only chicken and sam-sam but also fish, corn, and sausages. Key components, such as the charcoal tank and fan, remain, but the food holder and motor-driven rotation system ensure even cooking. The design, powered by a 12-volt DC wiper motor with 80 watts of power, 10 Nm torque, and 30 RPM speed, was tested and proven effective. The tool's frame is constructed from L-angle steel, iron plates, and an oil drum, with the chain cover made from angle and strip iron and the roasting axis from stainless steel rods. Testing confirmed that the tool operated efficiently without constant supervision, allowing users to perform other tasks during the grilling process, resulting in evenly cooked food.

Keywords: Ergonomics, Grilling, Wiper Motor Rotation

1 Introduction

The roasting process typically evaporates and reduces the water content in food, causing the fiber to shrink and making the food tougher (Onwukeme et al., 2016). The convection roasting method by Olayinka and Adegboye (2017) found average roasting times for corn cobs and plantains of 12 minutes and 20 minutes, respectively, compared to 15 minutes and 35 minutes for sweet potatoes and plantains. Oke (2013) conducted research using a manually operated multi-purpose charcoal grill and tested it with sweet potatoes, plantains, and corn cobs. The average roasting times were 15, 30, and 24 minutes, with completion rates of 95%, 97%, and 94%, respectively.

The phenomenon of selling grilled chicken using traditional grills, which often lack proper hygiene standards, is common. Placing the grill outside a restaurant or on the sidewalk can lead to contamination of the chicken, along with unhealthy grilling methods (Al-Mossawei et al., 2018). In roasting, products are exposed to dry heat over

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a fire or in an oven until enough moisture is removed to make the product suitable for immediate consumption (Ogunmoyela & Jimoh, 2023).

Several innovations have been made in meat roasting. For example, in the rotisserie chicken industry, a machine known as the 1425.4SMiE uses four independently motorized spits to increase chicken roasting capacity. This machine can roast 20 to 24 chickens in 1.5 hours (Rotisol, n.d.). Infrared grills, which replace conventional heating methods such as charcoal and gas, offer advantages like shorter preheating times and more even heat distribution (Bagheri, 2020). Compared to charcoal grills, which take 15 minutes to preheat, infrared burners take only 3 minutes, excluding the time needed to arrange and light the charcoal (Riches, 2023).

Large-scale industrial roasting machines are not suitable for small-scale restaurant operations. Small and medium-sized enterprises (SMEs) in the food industry need intelligent, energy-saving, cost-effective technology that is easy to operate and designed for small-scale use (Chia et al., 2021). For this reason, the present research aims to address the need for small-scale, energy-efficient, affordable, and healthy grilling technology by designing a model that uses an automatic wiper motor system. This system could help food vendors, particularly those offering grilled dishes.

This research seeks to answer two main questions: What is the model for grilling sam-sam and chicken meat using an automatic wiper motor system? How does this grill perform using the wiper motor system?

2 Methodology

This research focuses on designing a grilling machine. The product design method follows the approach developed by Sugiyono, which includes ten steps in the research and development strategy: identifying potential, data collection, product design, design validation, design revision, product testing, product revision, usage testing, product revision, and production. The design phase occurs after analyzing the system development cycle, defining functional needs, and preparing for implementation, which describes how the system is formed.

3 Result and Discussion

3.1 Result

The design of this combination grill uses a wiper motor as the main driver, along with sprocket teeth and a chain to transfer the rotation from the motor. A shaft is positioned above the chain, allowing it to rotate. The term “combination” refers to the grill's capability to cook not only sam-sam and chicken, but also other types of food such as fish, corn, or sausages. The use of an electric motor allows for controlling the rotation, which can be adjusted based on preferences and needs when grilling. In this design, the primary components of the grill, such as the charcoal tray and fan, remain in use. The

main difference lies in the food holder and the motor-driven rotation mechanism, which ensures the food rotates continuously for even cooking.

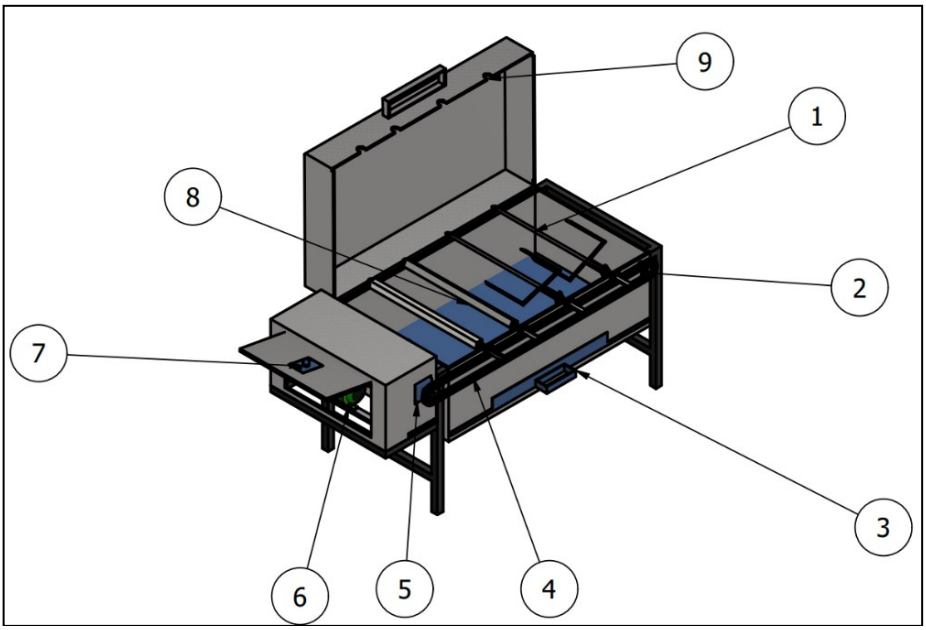

Figure 1. Design of combination grill

Information:

1	Chicken sticks	6	Blower
2	Sprocket	7	*Dimmers*
3	Charcoal holder	8	Sticks *Sam-sam*
4	Chain	9	Close the grill
5	Wiper motor		

The working principle of this combination grill for sam-sam and chicken relies on constant heat and a wiper motor. The wiper motor serves as the main driver to ensure even cooking, assisted by a dimmer control device that regulates the motor's speed. This allows the rotation speed (RPM) to be adjusted for optimal roasting. The grilling process is driven by the wiper motor, with the rotation transmitted through a chain and sprocket gears. A gear on the grilling shaft receives the rotation from the wiper motor, enabling the shaft to rotate. Charcoal is still used in the grilling process to retain the authentic flavor of Indonesian cuisine.

3.2 Discussion

The Working Principle. The working principle of this chicken roasting tool utilizes the concept of rotational motion. The axis or spindle holding the chicken rotates in sync with the electric motor. The main component of this tool is a 12-volt DC electric motor. The design process of this chicken roasting tool began with drafting the design using Autodesk Inventor 2020. The materials used include 40 mm steel angles for the frame, an oil drum, a T14 motorcycle front gear, a bicycle chain, a DC electric motor, and stainless steel rods with diameters of 12 mm and 10 mm. The result of the chicken roasting tool design is shown below:

Figure 2. Design results

Method Tool Work. The operation of this chicken roasting tool relies on rotational motion from the electric motor that spin the roasting axis, using AC power as the energy source. A 12-volt DC current is supplied to the motor through a choke and cable, which is connected to a power supply that converts single-phase AC power (220 volts) to 12-volt DC power. A dimmer is used to control the motor's RPM during the roasting process. When the dimmer is switched ON, the current flows to the motor's brushes/charcoal, which transmit the current to the commutator, causing the armature/rotor to rotate due to the magnetic force (stator) within the housing. This rotation is transferred to the pinion gear and then to the subsequent gear, allowing the final gear at the end of the DC motor to rotate at the specified ratio. A fan is attached to the armature/rotor to cool the motor and prevent overheating, while also keeping dirt out. When the dimmer is turned OFF, the current stops, and the armature/rotor ceases to rotate, halting the motor's operation.

Testing. Testing of the chicken roasting tool with the DC electric motor was conducted to ensure that all moving components functioned normally and that the tool could support the designed load of 10 kg. The test involved using various tools, including a grill, knife, bowl, spice brush, and thermogun, along with ingredients such as two whole chickens, charcoal, spice rub, and oil. The results showed that the speed of rotation was

12.2 RPM, and the distance between the food and the charcoal was maintained at 20 cm, ensuring optimal roasting performance.

Table 1. Test result data

No.	Amount meat (Kg)	Time (Minutes)	Temperature ºC)	Information
1	4 Kg (2 chickens)	60 minutes	60ºC	Ripe

The test results show that the grill, powered by a wiper motor system, successfully roasted 4 kg of chicken in 60 minutes at a stable temperature of 60°C, resulting in evenly cooked meat classified as “ripe”, as shown in Figure 3. This indicates that the grill design efficiently handles a large quantity of food, ensuring consistent rotation and heat distribution. The temperature control, regulated by the dimmer, allowed for a moderate cooking temperature that preserved the meat's moisture and tenderness, demonstrating the grill’s potential for maintaining food safety while delivering desirable cooking outcomes. These results suggest that the wiper motor-based grill is effective for roasting large portions and can be a suitable option for small-scale food vendors seeking an energy-efficient and reliable grilling method.

Figure 3. Test results showed 4 kg of chicken roasted for 60 minutes at 60°C, yielding evenly cooked and fully ripened meat

4 Conclusion

Based on the design and testing results, it can be concluded that the chicken roasting tool, driven by a 12-volt DC wiper motor with 80 watts of power, 10 Nm torque, and 30 RPM rotation, functions effectively. The frame of the tool is constructed from L-angle steel with various dimensions, along with other materials such as iron plates and

an oil drum for structural support. The chain cover and rail chain were made using angle and strip iron, while the roasting axis was made from stainless steel rods. During testing, the tool operated as expected without requiring constant supervision, allowing the user to perform other tasks, such as preparing spices, while the roasting process continued uninterrupted.

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