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Development of Power Operated Garlic Peeler

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Abstract:- Garlic bulbs are highly valued for their flavor and hold significant commercial importance due to their extensive medicinal properties and applications in food and pharmaceutical preparations. One of the essential preliminary steps before any subsequent processing activity is garlic peeling. Traditional methods such as hand peeling, flame peeling, oven peeling, and chemical peeling are commonly used in processing industries, large restaurants, hotels, and kitchens. However, these methods are laborious, time-consuming, cost-intensive, and limit the speed of processing activities. Due to its unique shape, mechanical peeling of garlic has not yet been effectively addressed by process engineers. Additionally, this task requires special care and skill to minimize material damage. With this in mind, a study was conducted to develop a power-operated garlic peeler aimed at alleviating the issues associated with traditional peeling methods and enhancing the processing and export of garlic and its products. The developed garlic peeler features a feed hopper, rubber pad, concave mechanism, and power transmission system. Its performance was evaluated at various combinations of shaft speed, feed rate mechanism, and operating speed.

Based on the results, optimal values for the study variables were recommended for the prototype garlic peeler, considering peeling efficiency and the yield of peeled and unpeeled garlic cloves. The performance of the prototype garlic peeler with the recommended specifications was then evaluated. The developed garlic peeler achieved an effective peeling efficiency of 71.93%, with a minimal percentage of damaged garlic at a speed of 850 rpm and an operating time of 80 seconds, with a capacity of 2.88 kg/hr at 850 rpm. Additionally, it was observed that the cost of operation for the developed garlic peeler was Rs. 1.89 per hour to peel 1 kg of garlic, which is lower than the cost associated with hand peeling.

Keywords-*: Garlic Peeler, Power Operated, Peeling Efficiency, Cost of Operation.*

I. INTRODUCTION

Garlic (Allium sativum L.), known as the spice of human life, is a significant perennial bulb crop grown widely across the plains of India. It is used as a spice or condiment throughout the country and is consumed by nearly everyone for culinary purposes. Garlic bulbs are highly valued for their flavor and hold extensive commercial importance due to their medicinal value and applications in food and pharmaceutical preparations. Post-harvest losses of garlic can range from 15-50%, depending on the variety and the post-harvest handling. These losses may increase if proper post-harvest management practices are not followed. To minimize these substantial losses, garlic needs to be processed. It can be transformed into various products such as garlic powder, garlic flakes, garlic paste, and garlic salt, which are in high demand in both domestic and international markets.

Garlic processing involves several key steps: bulb breaking, peeling, dehydration, grinding, packaging, and storage. Among these, garlic peeling is one of the most crucial and essential operations before any subsequent processing activity. During peeling, the thin membranous skin is removed from the garlic segments. Generally, the objective of peeling is to remove the outer layer. Selecting the proper peeling method is of prime importance, as the quality of the finished product largely depends on the method used. The amount of peel removed is significant to the processor because it represents a total loss, reducing product quantity, and the cost-intensive nature of peel disposal can cause environmental pollution. The aim of an effective peeling operation is to minimize product loss, energy and chemical usage, operation time, and peeling cost. Peeling not only enhances product quality by removing the non-edible outer skin but also accelerates the drying process, thereby reducing energy consumption and drying time.

Very little work has been done on garlic peeling, and the research that exists is mostly limited to traditional methods. These traditional methods—hand peeling, flame peeling, oven peeling, and chemical peeling—are commonly used in processing industries, large restaurants, hotels, and kitchens. However, these methods are laborious, time-consuming, cost-intensive, and restrict the speed of processing activities. The mechanical peeling of garlic has not been effectively addressed by process engineers due to the typical shape of garlic bulbs. Additionally, this unit operation requires special care and skill to minimize material damage. Therefore, it was proposed to develop a power-operated garlic peeler and evaluate its performance with various operating parameters. This innovation aims to alleviate the problems associated with traditional garlic peeling methods and boost garlic processing efficiency.

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II. MATERIALS AND METHODS

The variety G-282 of garlic was used for the experiment (Fig. 1), as it was identified as a suitable variety for processing and export purposes.

A. Development of Power Operated Garlic Peeler

A power-operated garlic peeler works on the principle of the concave-cylinder mechanism. The cylinder, coated with high-quality rubber rotating pads, peels the garlic by rotating against a fixed rubber concave, utilizing a combined rubbing action. The basic components of the developed garlic peeler include:

- *Feed Hopper*

The feed hopper, with a rectangular top and a trapezoidal bottom, was designed to simplify the process of feeding garlic into the peeling unit.

- *Concave Cylinder*

The rubber pad and concave rubber unit were utilized to peel garlic with minimal damage to the cloves and achieve maximum peeling efficiency. This unit primarily consists of a cylinder, known as a concave cylinder, coated with rubber. Inside the cylinder, rubber pads were mounted on the main shaft. The cylinder itself was constructed from a 244 mm diameter mild steel hollow pipe with a thickness of 4 mm and a length of 357 mm, sealed at both ends. Its outer surface was coated with 5 mm thick high-quality semi-hard silicon rubber. Two rubber pads were internally mounted on the shaft within the cylinder to facilitate the rubbing action on the garlic cloves. Given the lack of specific information on the required roller speed for garlic peeling, preliminary studies were conducted to determine the optimal range of pad speeds for experimental trials. Peripheral speeds of the pads considered for the trials were set at 60, 80, and 100 seconds for roller speeds of 800, 850, and 900 rpm, respectively.

- *Discharge Canal*

This unit includes a conveying and discharge assembly designed for peel separation and the discharge of a mixture of peeled and unpeeled garlic segments. It is mounted at the bottom side of the concave mechanism. The mixture, comprising peel, peeled garlic segments, and unpeeled garlic segments, is directed onto a tray. From there, the components fall through a discharge channel. Manually, operators separate the unpeeled garlic segments from the peeled ones, which are then fed back into the peeling unit for further processing. This setup is adjusted based on the angle of repose of garlic to optimize the separation process.

- *Power Requirement and Power Transmission*

The power for the garlic peeler was supplied by an electric motor, securely mounted on the machine frame. The motor had a capacity of 1 horsepower, single phase, and operated at 1440 rpm. The electrical circuit included a digital energy meter to measure energy consumption. To control the speed of the roller, a dimmer was employed. Two pulleys were utilized to connect the motor shaft to the concave shaft using a V-belt.

Fig 1: Garlic Sample

Fig 2. Developed Garlic Peeler

B. Working Procedure of Developed Garlic Peeler

Initially, the partially dried garlic bulbs were manually broken and the cloves were separated. During testing, the peeler was installed on level ground and operated without any load to verify the proper functioning of each component. Experiments were conducted according to the experimental plan. Each test involved feeding 100 grams of graded garlic sample into the hopper. Three replications were performed for each combination of variables to ensure reliability and consistency of the results.

C. Performance Evaluation of Developed Garlic Peeler

It was measured in terms of the following parameters.

- *Peeling Efficiency (E)*

It was calculated as per the formula shown in equation (1).

$$E = \left(1 - \frac{M_u}{M_t}\right) \times \left(1 - \frac{M_d}{M_t}\right) \times 100 \quad \text{..... (1)}$$

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Where,

M_u = Mass of unpeeled garlic, gm
M_d = Mass of damaged garlic, gm
M_t = Mass of total garlic used for peeling, gm

➢ *Undamaged Peeled Garlic*

The recovery of undamaged peeled garlic cloves was determined based on weight. After processing, undamaged peeled garlic cloves were manually separated from the mixture that included unpeeled and damaged peeled garlic segments. These undamaged cloves were then weighed to assess the efficiency of the peeling process.

➢ *Unpeeled garlic Cloves*

The unpeeled garlic cloves were manually separated from the mixture of undamaged and damaged garlic segments, and then their weight was measured.

➢ *Damaged Garlic Cloves* –

The damaged garlic cloves were manually separated from the mixture of undamaged peeled and undamaged unpeeled garlic segments, and their weight was then measured.

III. RESULTS AND DISCUSSION

The results of the studies conducted at different levels of variables are presented in Fig. 3. For the speed of 800 rpm, it was noted that increasing the operating time of the developed peeler led to a decrease in peeling efficiency. This decrease was attributed to a higher percentage of damaged or unpeeled garlic as the operating time increased. Consequently, the optimal effective operating time for this speed was determined to be 60 seconds. For the speed of 850 rpm, it was observed that increasing the operating time of the developed peeler resulted in an increase in peeling efficiency. This improvement was due to a decrease in the percentage of damaged or unpeeled garlic as the operating time increased. Therefore, the effective operating time interval for this speed was found to be 100 seconds.

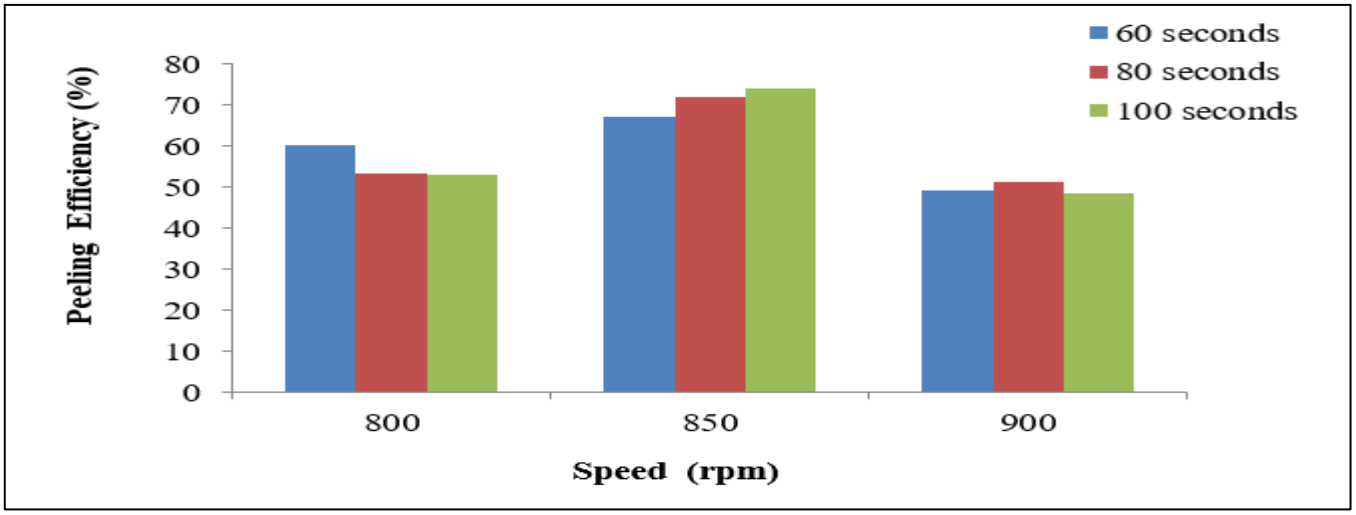

Fig 3: Effect of Speed on Peeling Efficiency of Developed Peeler at Different Operating Time

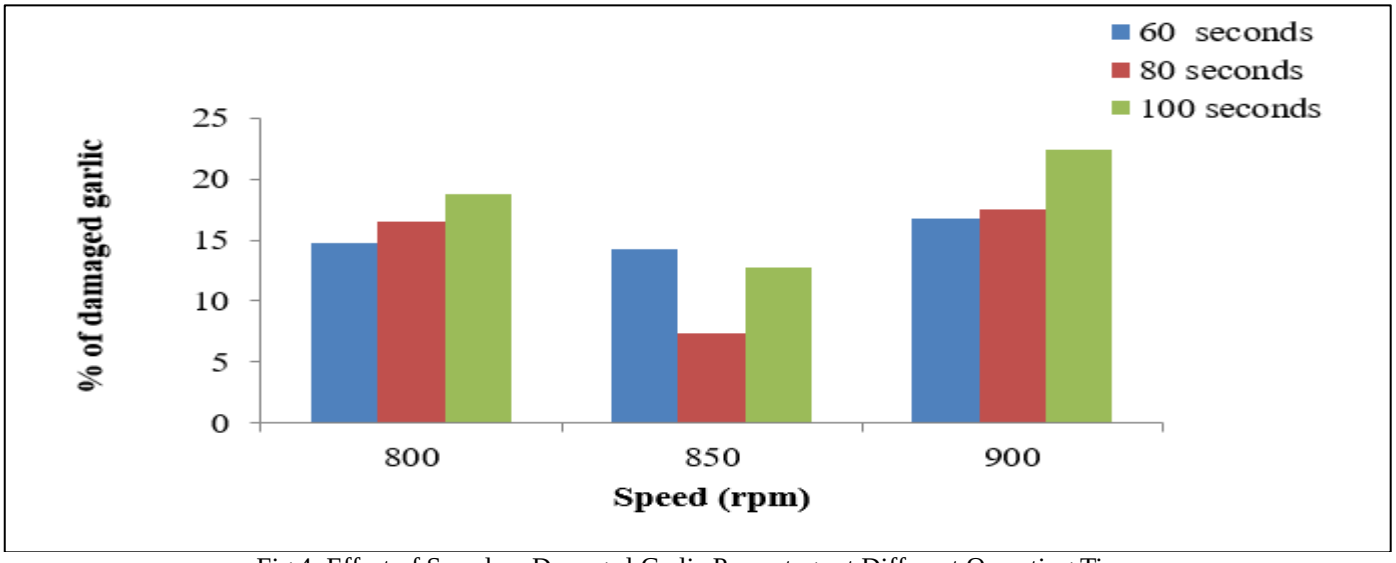

Fig 4: Effect of Speed on Damaged Garlic Percentage at Different Operating Time

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For the speed of 900 rpm, the study showed that increasing the operating time of the developed peeler up to 80 seconds led to an increase in peeling efficiency. However, beyond 80 seconds, peeling efficiency started to decrease at 100 seconds of operating time. This decline could be attributed to an increase in the percentage of damaged or unpeeled garlic as the operating time exceeded the optimal point. Therefore, the effective operating time interval for this speed was determined to be 80 seconds.

Thus, the effective peeling efficiency with minimum damage was observed at the speed of 850 rpm and an operating time of 80 seconds. Additionally, it was noted from Fig. 4 that higher speeds resulted in maximum damage to the garlic, while lower speeds also caused significant damage. Therefore, maintaining the speed of the concave cylinder is crucial to achieving optimal peeling efficiency with the peeler.

The fabrication cost of the developed garlic peeler was calculated to be Rs. 9470/-, while its processing capacity was determined to be 2.88 kg/hour at a speed of 850 rpm. The operational cost of the garlic peeler was estimated at Rs. 1.89/- per hour to peel 1 kg of garlic, assuming a 5-year working life with 5000 hours of operation annually. This operational cost was found to be lower than that of a hand peeler.

IV. CONCLUSIONS

- The durable and cost-effective power-operated garlic peeler can be easily fabricated as a prototype model with an operational cost of Rs. 1.89/- per hour, making it highly recommended for food processors and restaurants.
- As the peeling efficiency of this peeler depends on the speed of operation, the optimum peeling efficiency of 71.93% can be achieved at 850 rpm.

REFERENCES

[1]. Dhananjay G. Dange, Dr. S. K. Choudhary and A. P. Ninawe, “Methodology for Design and Fabrication of Garlic Peeling Machine-A Review”, International Journal for Scientific Research & Development, Vol. 2(11), 2015, pp. 2321-0613.
[2]. K. Rajesh, M. Kirthy Reddy, Y. Anusha, P. Haritha, D. Narendra, and S. Srujana, “Design and Fabrication of Garlic Peeler”, International Journal of Advanced Engineering Research and Science (IJAERS), Vol.5 (7), 2018.
[3]. Maninder Kaur, Preetinder Kaur and Mahesh Kumar, “Development and Fabrication of Small Capacity Garlic Peeler”, International Journal of Current Microbiology and Applied Sciences, Vol. 8(8), 2019, pp. 619-634.
[4]. Sayed Khater,”Development and Evaluation of a Garlic Peeling Machine”, Annals of Agricultural Science, Moshtohor, Vol. 59(4), 2021, pp. 893-906.