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(Research Article)

Design and performance evaluation of an enhanced cassava slicing machine

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Abstract

Cassava (Manihot esculenta Crantz) plays a crucial role in the Philippines as a staple food and a key raw material for various industries. Despite its significance, traditional cassava slicing methods remain labor-intensive and inefficient, resulting in inconsistent product quality. This study presents the Design and Performance Evaluation of an Enhanced Cassava Slicing Machine aimed at improving processing efficiency, safety, and product quality. The machine incorporates optimized blade configuration, motor power, and a locally sourced, simple mechanical system. The performance evaluation, conducted with 40 participants, revealed excellent ratings across key operational parameters: capacity, efficiency, speed, and durability, with a grand mean of 4.50 (Excellent). Additionally, user acceptability was highly favorable, with an overall mean of 4.46, indicating strong approval from both technical instructors and local farmers. The findings demonstrate that the enhanced slicing machine improves slicing uniformity, reduces processing time, and minimizes operator fatigue compared to manual methods. This technology-based intervention highlights the potential of localized engineering innovations to improve post-harvest operations, support food security, and enhance rural livelihoods.

Keywords: Cassava Slicing Machine; Performance Evaluation; Processing Efficiency; User Acceptability; Localized Engineering Innovations

1. Introduction

Cassava (Manihot esculenta Crantz) is a vital root crop serving as a staple food and a key source of industrial raw materials in many developing countries. In the Philippines, cassava plays a crucial role in rural livelihoods, providing income for smallholder farmers and serving as a raw material for flour, starch, and bioethanol production (FAO, 2021). However, traditional postharvest processing methods, particularly manual slicing, remain labor-intensive and inconsistent, leading to inefficiencies in drying and reduced product quality (Bolaji, Adejuyigbe, and Ayodeji, 2011). These constraints highlight the need for mechanized solutions to improve processing efficiency, uniformity, and productivity.

Recent technological advancements have enabled the development of cassava slicing machines designed to address the limitations of traditional methods. Studies have demonstrated that machine-based processing significantly improves slicing precision, reduces contamination risks, and enhances drying uniformity compared to manual techniques (Singhpoo et al., 2023). Similarly, the design and fabrication of semi-automatic slicing and chipping devices have shown potential for improving output capacity and operator safety (Sutopo and Kusumawati, 2025). Adefidipe et al. (2024) further emphasized that optimizing blade configuration and rotary speed in slicing machines can substantially increase throughput while maintaining consistent slice thickness.

In the local context, technological interventions play a key role in supporting small-scale agro-industrial innovation. Baldos (2025) introduced a Technology-Based Intervention Framework for Barangay Plaridel, Palompon, Leyte, which

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underscores the importance of integrating appropriate technologies to improve livelihood sustainability and local productivity. Moreover, the works of Baldos and Sabang (2025) and Baldos and Chavez (2025) have shown that developing instructional and simulator-based technologies enhances both operational efficiency and learning outcomes in applied technical fields. These studies demonstrate how localized innovation and applied engineering can serve as catalysts for productivity and skills development.

In response to these challenges and insights, this study was conducted to Design and Performance Evaluation of an Enhanced Cassava Slicing Machine. Specifically, it sought to: (1) improve slicing capacity through optimized blade configuration and motor power, (2) assess the machine's performance in terms of speed, durability, and efficiency, and (3) determine its acceptability among users based on design, functionality, and safety.

2. Methodology

2.1. Project Design and Fabrication

The design of the cassava slicing machine aimed to modernize traditional slicing practices by integrating a simple yet efficient mechanical system utilizing locally available materials. The primary components of the machine include a main frame, feeding channel, discharge chute, conveying disc, and a three-blade cutting assembly powered by an electric motor (figure 1). The fabrication process involved standard mechanical workshop procedures such as metal cutting, welding, machining, assembly, and surface finishing to enhance the machine's durability and corrosion resistance.

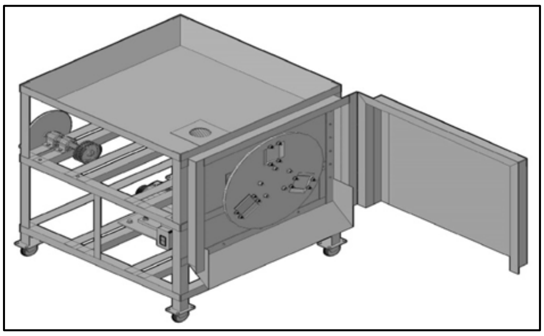

Figure 1 the construction of Cassava Slicing Machine

During the preliminary trials, it was observed that smaller cassava tubers were not properly aligned with the feeding mechanism. To address this issue, an adapter was incorporated to accommodate varying tuber diameters, improving slicing uniformity and overall productivity (figure 2). The enhanced design ensured consistent slice thickness, reduced manual handling, and promoted operator safety during operation.

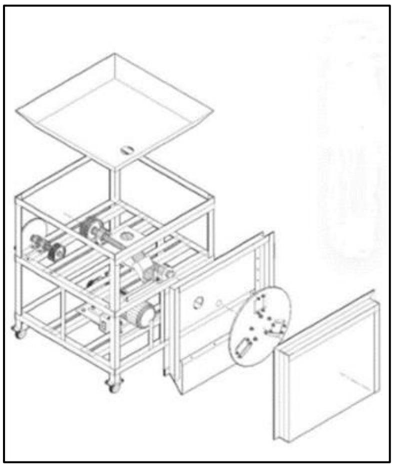

Figure 2 Exploded Design of Cassava Slicing Machine

2.2. Testing and Evaluation

The performance evaluation of the enhanced cassava slicing machine focused on four major parameters: capacity, efficiency, speed, and durability. A total of 40 respondents participated in the assessment—comprising 20 instructors from the College of Technology and Engineering and 20 local cassava farmers—to represent both technical and practical user perspectives.

A structured five-point Likert scale questionnaire was employed to evaluate the machine's performance (1 = Poor to 5 = Excellent) and acceptability (1 = Not Acceptable to 5 = Very Acceptable). The responses were statistically analyzed using descriptive statistics, specifically mean and standard deviation, to determine the overall level of performance and user acceptability of the developed machine. The evaluation process provided empirical insights into the efficiency, reliability, and usability of the slicing system under typical operating conditions.

3. Results and Discussion

3.1. Performance Evaluation

The performance evaluation of the enhanced cassava slicing machine revealed consistently excellent ratings across all operational parameters, as shown in Table 1. The capacity criterion achieved an average mean of 4.46, indicating that the machine could process large quantities of cassava efficiently per minute and per hour. The efficiency parameter recorded the highest mean of 4.52, reflecting the optimized motor drive and sharp three-blade cutting assembly that ensured uniform slice thickness and minimal wastage.

The speed criterion obtained a mean score of 4.49, confirming that the blade rotation rate supported rapid and uniform slicing performance. Similarly, the durability parameter received a high mean of 4.53, attributed to the sturdy frame construction, reliable feeding mechanism, and corrosion-resistant finishing. The computed grand mean of 4.50 was interpreted as excellent, indicating that the machine performed very efficiently, rapidly, and reliably under continuous operation.

Table 1 Performance Evaluation of the Enhanced Cassava Slicing Machine (n = 40)

Performance Criteria	Mean (M)	Verbal Interpretation
Capacity	4.46	Excellent
Efficiency	4.52	Excellent
Speed	4.49	Excellent
Durability	4.53	Excellent
Grand Mean	4.50	Excellent

Interpretation Scale: 1.00–1.80 = Poor | 1.81–2.60 = Fair | 2.61–3.40 = Good | 3.41–4.20 = Very Good | 4.21–5.00 = Excellent

The results validate that the enhanced cassava slicing machine successfully improved slicing uniformity and throughput compared to manual methods. These findings are consistent with Bolaji et al. (2011) and Azetidine et al. (2024), who emphasized that optimized mechanical design, blade arrangement, and material strength are essential for achieving superior machine performance in root crop processing.

3.2. Acceptability Assessment

The acceptability evaluation showed strong user approval of the machine's design, performance, and safety. As presented in Table 2, the respondents rated the machine as very acceptable in all aspects, with design (M = 4.51) receiving the highest score, followed by performance (M = 4.50) and safety (M = 4.38). The overall acceptability mean of 4.46 confirms that both instructors and cassava farmers perceived the equipment as efficient, user-friendly, and suitable for small-scale production.

Table 2 Acceptability Evaluation of the Enhanced Cassava Slicing Machine (n = 40)

Acceptability Criteria	Mean (M)	Verbal Interpretation
Design	4.51	Very Acceptable
Performance	4.50	Very Acceptable
Safety	4.38	Very Acceptable
Overall Mean	4.46	Very Acceptable

Interpretation Scale: 1.00–1.80 = Not Acceptable | 1.81–2.60 = Slightly Acceptable | 2.61–3.40 = Moderately Acceptable | 3.41–4.20 = Acceptable | 4.21–5.00 = Very

3.3. Acceptable

Minor areas for improvement were identified, such as adjusting the idler pulley, shaft alignment, and discharge chute orientation, to further enhance feeding continuity and operator comfort. These results align with Baldos and Sabang (2025) and Baldos and Chavez (2025), who highlighted that iterative design refinement and user-centered feedback significantly improve machine reliability and operator satisfaction.

4. Conclusion

The design, development, and enhancement of the cassava slicing machine successfully addressed the inefficiencies of manual cassava processing. With an overall grand mean rating of 4.48, the machine was evaluated as excellent, very efficient, very durable, and very safe. Its performance significantly improved slicing uniformity, reduced processing time, and minimized operator fatigue compared with traditional manual methods.

The results affirm that localized engineering innovations can play a vital role in strengthening food security and agricultural productivity by optimizing post-harvest operations. Furthermore, the machine's dual-mode (auto–manual) configuration enhances adaptability in rural areas with inconsistent power supply, making it a practical and sustainable technology-based intervention for community livelihood improvement.

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