International Journal of Sustainable and Integrated Studies
Volume 1, Issue 2 | ISSN: 3155-6361
DOI: https://doi.org/10.65339/ijsis.V1.I2.97

2-in-1 Cassava Processor: An Innovative Design for Kakanin Implements

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Publication history:

Received: August 16, 2026 Accepted: September 17, 2026
Revised: September 11, 2026 Published: September 18, 2026

International Journal of Sustainable and Integrated Studies, Vol. 1, No. 2, pp. 412–420, September 2026.

Abstract

This study developed and evaluated a 2-in-1 cassava processor designed to combine grating and pressing operations for small-scale kakanin production. The project was anchored in mechanical engineering, food-processing, ergonomics, appropriate technology, and systems theory. A developmental research design was used, incorporating planning, CAD-based design, fabrication, prototyping, testing, revision, and evaluation. The machine was assessed for workability in grating and pressing and for acceptability in terms of design, usability, convenience, and safety. Thirty kakanin vendors, business owners, and community members from Kidapawan City participated through purposive sampling. Data were collected using a researcher-developed questionnaire validated by three experts, obtaining a mean validation score of 4.06, interpreted as “Highly Valid.” Frequency count and mean were used to analyze the data. Grating performance was classified as “Workable,” with a mean processing time of 2.27 minutes, mean starch output of 180 g, mean pulp output of 620 g, and mean liquid extraction of 202 mL. Pressing performance was classified as “Moderately Workable,” with a mean processing time of 2.71 minutes, mean starch output of 171 g, mean pulp output of 605 g, and mean liquid extraction of 232 mL. Starch adhesion initially affected extrusion and extraction, but water application, a presser plate, and a press cage improved material flow and pressure distribution. The processor was rated “Acceptable” in design, usability, and safety and “Highly Acceptable” in convenience. Further improvements are needed in pressing efficiency, system integration, maintenance access, electrical protection, and continuous-operation safety. The study supports SDG 8 – Decent Work and Economic Growth, SDG 9 – Industry, Innovation and Infrastructure, and SDG 12 – Responsible Consumption and Production. Its sustainability impact lies in reducing manual effort and processing time, supporting small-scale food enterprises, promoting practical technological innovation, and encouraging more efficient use of cassava outputs and by-products.

Keywords: Acceptability; Cassava Grater and Presser; Kakanin Production; Mechanical Processing; Small-Scale Processing; Sustainability; 2-In-1 Cassava Processor; Workability

1. Introduction

Traditional cassava processing commonly uses manual graters or pounding methods that require considerable physical effort and extended processing time. These practices may also create sanitation and safety concerns because conventional materials can corrode, become difficult to clean, and contaminate cassava products (Umani et al., 2020; Nnanna et al., 2023). Cassava is also susceptible to quality and safety problems during processing because its fluid is acidic and may react with non-food-grade machine materials (Mose et al., 2025).

Technological developments have attempted to improve cassava processing. Earlier manual-or-electric graters, for example, provide flexibility in areas with limited or unreliable electricity. However, many such devices focus only on grating, leaving pressing as a separate operation. Other developments have likewise addressed individual processing stages. Nnanna et al. (2023) improved grating performance through modified mesh surfaces and stainless-steel components. Yusuf et al. (2019) developed a pedal-operated grater using locally available materials and achieved a grating efficiency of 90.91%. Esteves et al. (2019) produced a motor-operated grater with adjustable drum speed and achieved a grating efficiency of 91.56%.

Pressing is an essential stage in cassava processing because it removes excess moisture from grated cassava pulp and supports the production of products such as gari, fufu, and cassava flour (Precoppe, 2023). Previous studies have developed screw-type, vertical-squeeze, and motorized cassava-processing machines. Amoshie et al. (2023) developed a torsional compression screw press that reduced moisture content from 70% to 15% in approximately three minutes. Olusegun and Ajiboye (2010) developed a motorized vertical-squeeze dewatering machine that processed 200 kg of cassava pulp in approximately 34 minutes. The reviewed developments demonstrate that mechanization can improve cassava-processing efficiency, reduce physical labor, and support more hygienic production. Nevertheless, many existing machines address only one stage of processing or require separate equipment for grating and pressing. This limitation supports the development of an integrated processor capable of performing both functions in one compact unit.

The literature identifies several recurring themes relevant to the development of the 2-in-1 cassava processor. First, mechanization improves productivity and reduces labor requirements. Traditional grating and pressing are slow and physically demanding, whereas motorized systems can produce more consistent outputs within shorter periods (Umani et al., 2020; Esteves et al., 2019). Grating efficiency is influenced by drum speed, blade or mesh design, feed rate, and the uniformity of cassava input (Nnanna et al., 2023; Sarpong et al., 2024; Ertebo & Koroso, 2024). Second, material selection and sanitation are essential in food-processing equipment. Stainless steel and other corrosion-resistant materials help reduce contamination and improve machine durability, particularly because cassava fluid can cause corrosion (Mose et al., 2025). Third, pressing performance depends on pressure distribution, mash density, moisture content, and the mechanical stability of the pressing chamber. Effective compression improves moisture removal and product recovery, while inconsistent pressure may produce variations in liquid extraction and starch retention.

Fourth, integrated machine design can reduce processing stages and improve convenience. Combining grating and pressing may reduce labor, space requirements, and processing time. However, integration can also create problems involving component synchronization, mechanical resistance, alignment, vibration, maintenance, and safety (Adekanye et al., 2025; Sarpong et al., 2024). Finally, user acceptability depends not only on technical performance but also on usability, convenience, accessibility, maintenance, safety, and ergonomic design. Simple controls, clear instructions, reduced operator effort, and accessible components influence the adoption of agricultural technologies. These findings support the need to evaluate the processor in terms of design, usability, convenience, and safety in addition to grating and pressing workability.

Globally, cassava contributes to food security, rural employment, and agricultural resilience because it can produce carbohydrates under challenging growing conditions. Its roots are a major source of starch and dietary energy, and cassava products are consumed in various forms worldwide (Pharma Innovation Journal, 2022). Cassava processing can also support income generation and economic activity in developing communities (Mose et al., 2025). At the local level, cassava is relevant to small-scale food production and kakanin preparation. Vendors and community-based processors often require equipment that is compact, practical, manageable, and appropriate for limited-resource settings. The 2-in-1 cassava processor was designed for this context by integrating grating and pressing operations into one electrically operated unit. Its use of a motor, mechanical transmission system, pressing mechanism, drainage components, caster wheels, and circuit breaker responds to the need for more efficient, mobile, and safer small-scale processing. The study was situated in Kidapawan City and involved kakanin vendors, business owners, and community members as evaluators. Their assessment addressed whether the machine could provide a practical alternative to fragmented manual processing. The local focus is therefore connected to broader concerns involving food production, livelihood support, appropriate technology, rural enterprise, and the reduction of labor-intensive processing.

The study is grounded in mechanical engineering, food processing, ergonomics, appropriate technology, and systems theory. From a mechanical-engineering perspective, the machine applies motion dynamics and simple-machine principles. Motor power is transmitted through rotating components, chains, sprockets, belts, pulleys, rollers, and shafts to perform grating and pressing operations. The integration of grating and pressing may improve efficiency, reduce labor, and increase productivity. The food-processing basis emphasizes moisture removal, product quality, and food safety. Mechanical pressing assists in moisture removal and may reduce the concentration of undesirable compounds while improving product quality. The ergonomic and appropriate-technology perspectives emphasize reduced physical strain, simplified operation, convenience, and suitability for small-scale users. The machine consolidates two processing operations to reduce manual handling and improve workflow. Its safety features, including protective components and a circuit breaker, support safer operation. The study also adopts a systems perspective in which the hopper, grater, presser, motor, transmission components, drainage system, and collection tray function as interconnected parts. The conceptual process follows an input-process-output sequence. Inputs include ideas, references, materials, tools, equipment, labor, trials, and the questionnaire. The process includes planning, designing, constructing, testing, revising, and evaluating. The output is the completed 2-in-1 cassava processor for kakanin production.

The literature shows substantial progress in cassava grating, pressing, dewatering, and other processing technologies. However, many existing machines focus on only one processing stage. Grating and pressing are frequently performed using separate equipment, which increases handling, space requirements, processing stages, labor, and time. A further gap concerns the integration of mechanical systems. Combining grating and pressing requires appropriate coordination of power transmission, material flow, pressure application, alignment, cleaning, and safety features. Existing studies also indicate continuing challenges involving corrosion, inconsistent pressure, starch adhesion, output variability, component accessibility, and user protection (Mose et al., 2025; Adekanye et al., 2025; Sarpong et al., 2024). The present study addresses these gaps by designing and constructing a single machine that performs both grating and pressing. It evaluates the machine's workability in grating and pressing and determines its acceptability in terms of design, usability, convenience, and safety. The study is justified by the need for a compact, practical, labor-saving, and user-oriented processor suitable for small-scale cassava and kakanin production.

The study naturally aligns with the following Sustainable Development Goals: SDG 8 – Decent Work and Economic Growth. The processor is intended to reduce labor intensity, shorten processing time, and support the productivity of kakanin vendors and small-scale business owners. SDG 9 – Industry, Innovation and Infrastructure. The study develops an integrated agricultural-processing technology that combines grating and pressing in one machine. It contributes to practical innovation in small-scale food-processing equipment. SDG 12 – Responsible Consumption and Production. The machine supports more efficient cassava processing by reducing unnecessary handling and encouraging the productive use of starch, liquid, and pulp outputs. The fibrous residue may also support secondary applications such as animal feed or composting materials. SDG 11 – Sustainable Cities and Communities. By supporting locally appropriate food-processing technology and small-scale community enterprises, the project contributes to community-level productivity and livelihood development. The study also relates to environmental and technological sustainability because it promotes more efficient processing, encourages reduced material loss, and applies an integrated design intended to improve the use and maintenance of processing equipment.

The study contributes to socio-economic sustainability by providing a machine intended to reduce labor requirements, processing time, and operational burden for kakanin vendors and small-scale business owners. Greater processing efficiency may support productivity and income-generating activities. It contributes to technological sustainability through the design of a locally applicable machine that integrates two processing functions. The use of a compact structure, mechanical power transmission, corrosion-resistant components, mobility features, and overload protection reflects an effort to develop practical and maintainable equipment for small-scale users. The study supports food-processing and public-health sustainability by incorporating hygiene and safety considerations into the design. Corrosion-resistant and food-appropriate materials, improved drainage, cleaning assistance, protective components, and a circuit breaker are intended to support safer processing conditions. It also contributes to environmental sustainability by promoting more efficient resource use and reducing avoidable processing losses. The separation of starch, liquid, and fibrous pulp creates the possibility of using by-products rather than treating them solely as waste. Finally, the project supports community sustainability by responding to the practical needs of local vendors, business owners, and community members in Kidapawan City. Its multidisciplinary basis—combining mechanical engineering, food processing, ergonomics, appropriate technology, and livelihood development—positions the 2-in-1 cassava processor as a technology-oriented intervention for more efficient and sustainable small-scale food production.

2. Material and methods

2.1 Research Design

The study employed a developmental research design focused on the design, fabrication, and evaluation of a 2-in-1 cassava processor. An engineering approach incorporating design thinking, prototyping, testing, and revision was used to assess the machine's functionality, cost-efficiency, workability, and user acceptability. The development process followed an input-process-output sequence. Inputs included the researcher's ideas, related references, materials, tools, equipment, labor, trials, and questionnaire. The process consisted of planning, designing, constructing, testing, revising, and evaluating the machine. Revisions were made when malfunctions or performance limitations were identified. The resulting output was the completed 2-in-1 cassava processor designed for kakanin production. The machine was constructed as a compact electrically operated unit that integrates cassava grating and pressing. Its major components included a mild-steel frame, grating unit, hopper, rollers, flywheel, motor, chain-and-sprocket system, belt-and-pulley system, pressing cage, presser plate, drainage components, starch collection system, caster wheels, water dispenser, and circuit breaker. The motor supplied power for the grating and mechanical transmission systems, while the presser supported the extraction of liquid from grated cassava pulp.

The fabrication began with the preparation, cutting, welding, leveling, and cross-bracing of the main frame. The grating housing was then constructed from corrosion-resistant materials, followed by the installation of the grating drum, rollers, flywheel, power-transmission system, motor, hopper, and feeding mechanism. The pressing and extrusion system was assembled with the pressing cage, presser plate, lever mechanism, drainage components, and starch collection containers. Electrical wiring, the motor, circuit breaker, water dispenser, and protective coverings were subsequently installed. The machine was subjected to alignment checks, dry-run testing, and actual cassava-processing trials. During the initial operation, cassava starch adhered to the extruder and interfered with material flow and extraction. Water was introduced to reduce adhesion and improve the movement of cassava through the extruder. Because the initial extraction remained limited, a presser plate and press cage were incorporated to improve pressure distribution, reduce material accumulation, and increase extraction efficiency. The machine was then cleaned, painted, fitted with safety guards, and inspected for stable and safe operation. The construction period covered twelve weeks. Planning and design required two weeks, preparation of materials required one week, construction required four weeks, testing, revision, and evaluation required two weeks, and report writing required three weeks. The materials had a reported cost of PhP 23,503.00, labor cost was PhP 10,000.00, contingency was PhP 5,000.00, and the total project cost was PhP 38,503.00.

2.2 Locale of the Study

The study was conducted in Kidapawan City. The location was selected because it included the intended users and evaluators of the machine, particularly kakanin vendors, business owners, and community members involved in or familiar with small-scale cassava-based food production.

2.3 Respondents of the Study

The respondents consisted of thirty (30) kakanin vendors, business owners, and community members from Kidapawan City. They participated in the user evaluation of the 2-in-1 cassava processor and assessed its acceptability in terms of design, usability, convenience, and safety.

2.4 Sample and Sampling Procedure

The study used thirty (30) respondents selected through purposive sampling. Individuals were chosen because they had knowledge of or experience with the project's intended application and were among the potential beneficiaries of the equipment. The participants included kakanin vendors and business owners, together with community members from Kidapawan City.

2.5 Research Instrument

The researcher developed a questionnaire to evaluate the 2-in-1 cassava processor. Three experts with relevant knowledge and experience reviewed and validated the instrument. The questionnaire obtained a mean validation score of 4.06, interpreted as "Highly Valid," indicating that it was considered suitable for gathering relatively unbiased data, with an allowable error range of 8–10%. The instrument evaluated the machine's acceptability in terms of design, usability, convenience, and safety. It also included a section for comments and suggestions to support further improvement of the project. A four-point Likert scale was used, with 4 representing the highest level of acceptability and 1 representing the lowest. The ratings were interpreted as "Highly Acceptable," "Acceptable," "Moderately Acceptable," and "Highly Not Acceptable." The study also used a workability scale for the machine's processing time. A mean processing time of 1.00–1.74 minutes was interpreted as "Highly Workable," 1.75–2.49 minutes as "Workable," 2.50–3.24 minutes as "Moderately Workable," and 3.25–4.00 minutes as "Not Workable."

2.6 Data Gathering Procedure

The researcher first prepared the survey questionnaire and submitted it to the research adviser and three panel members for validation, feedback, and improvement. The instrument was revised according to their recommendations to improve its clarity, relevance, and reliability. The study also underwent an ethics review to ensure that appropriate research standards, participant welfare, and ethical considerations were observed. A formal letter of request was prepared and submitted to the Office of the Administrator of the Mega Market to obtain permission to conduct the survey. After approval, the signed authorization was secured and retained by the researcher. The validated questionnaires were personally distributed to the selected respondents. Before answering, the participants were informed about the purpose and scope of the study. They were also assured that the information they provided would remain confidential and would be used exclusively for academic purposes. After completion, the questionnaires were immediately collected. The responses were encoded and organized using Microsoft Excel. The data were then analyzed, interpreted, and discussed in relation to the objectives of the study. The machine itself underwent fabrication, assembly, dry-run testing, and actual cassava-processing trials. The researcher assessed the grating and pressing operations using cassava input, added water, processing time, starch output, pulp output, and liquid extraction. Defects identified during testing were addressed through operational and structural revisions, including the use of water to reduce starch adhesion and the installation of a presser plate and press cage to improve extraction.

2.7 Data Analysis Techniques

The study used a four-point Likert scale to analyze respondent evaluations. Frequency count and mean were used to determine the acceptability of the 2-in-1 cassava processor in terms of design, usability, convenience, and safety. For workability testing, the processing time and output measurements from the grating and pressing trials were recorded and summarized using mean values. The evaluated outputs included cassava starch quantity, cassava pulp quantity, liquid extracted, and processing time. The resulting means were interpreted using the established workability ranges. The collected data were tabulated, interpreted, and related to the objectives of the study. Frequency count described the distribution of responses, while mean values determined the general level of acceptability and workability of the machine.

3. Results and Discussion

3.1 Development and Construction of the Processor

3.1.1 Completed Machine Design

The 2-in-1 cassava processor was successfully completed after several weeks of construction. CAD was used to establish the dimensions and arrangement of the components. The machine integrated cassava grating and pressing in one electrically operated unit. Its primary frame was made from mild-steel square bars that were cut, welded, and cross-braced for stability, strength, and vibration resistance. Corrosion-resistant materials were used for the grating unit, which included a stainless-steel grating drum, rollers, flywheel, motor, chain, sprocket, belt, and pulley system. The machine also included a hopper, pressing and extrusion components, drainage channels, starch collection parts, circuit breaker, safety covers, caster wheels, and a water dispenser. During initial operation, cassava starch adhered to the extruder, obstructing mash discharge and reducing extraction efficiency. Water was added to improve material flow and reduce adhesion. Because extract recovery remained limited, a presser plate and press cage were installed to improve pressure distribution, moisture removal, and pressing output. The final assembly included component alignment, tightening of connections, dry-run testing, actual cassava-processing trials, painting, installation of safety covers, and final safety inspection.

The completed design demonstrated that the machine could combine grating and pressing operations within one structure while incorporating stability, mobility, drainage, and safety features. However, the initial problems involving starch adhesion and low extract recovery showed that integrated processing required further mechanical adjustment. Sarpong et al. (2024) confirmed the importance of appropriate assembly, structural stability, safety features, and effective component integration in cassava-processing machines. Their findings showed that properly aligned machines with robust frames and reliable operating systems improve usability and processing efficiency at the small-scale level. The present results are consistent with these findings because final assembly, modification of the pressing mechanism, and safety improvements contributed to the processor's functionality and reliability despite limitations in extraction efficiency.

3.1.2 Fabrication and System Integration

The machine was fabricated sequentially, beginning with the main frame and ending with final assembly and testing. The mild-steel frame was cut, welded, and reinforced with cross-bracing. The grating unit was constructed from corrosion-resistant materials and fitted with a grating drum, rollers, flywheel, and power-transmission components connected to the electric motor. The hopper and feeding mechanism were arranged to support continuous cassava delivery into the grating chamber. The pressing and extrusion system was assembled to extract juice and starch from grated cassava. Rollers, drainage components, and a starch collection system supported the separation and collection of outputs. Starch adhesion initially disrupted material flow, but the addition of water improved lubrication and reduced obstruction. The presser plate and press cage subsequently improved pressure distribution, load stability, and extraction performance. The motor and circuit breaker provided regulated operation and overload protection.

The results indicate that the machine operated as an integrated system, but its performance depended on the proper coordination of feeding, grating, pressing, extrusion, drainage, and power-transmission components. The need for water and additional pressing components demonstrated that the first configuration required revision before achieving improved operation. Moisture adjustment is known to influence material flow and processing efficiency in cassava and starch extrusion systems. The fabrication process also agrees with Adekanye et al. (2025), who reported that properly constructed frames, power-transmission systems, and grating drums improve throughput, efficiency, and machine longevity. Abama et al. (2024) similarly noted that feed hoppers, pulley-driven grating systems, and reinforced support structures improve machine stability and operational efficiency.

3.2 Workability of the Processor

3.2.1 Grating Performance

The grating trials used 1 kg of cassava and 250 mL of water. Across three trials, processing time ranged from 2.04 to 2.45 minutes, with a mean of 2.27 minutes, interpreted as "Workable." Starch output ranged from 175 g to 185 g, with a mean of 180 g. Cassava pulp ranged from 615 g to 625 g, with a mean of 620 g, while liquid extraction ranged from 195 mL to 211 mL, with a mean of 202 mL. All trials produced grated cassava and were classified as workable. The results show that the processor produced relatively consistent starch, pulp, and liquid outputs within a short processing period. The mean starch yield indicates effective breakdown of cassava tissue, while the stable pulp output indicates separation of fibrous residues from the starch-rich slurry. The consistent liquid output also suggests that the grating intensity and feeding rate were reasonably stable. Minor variations indicate that the feeding mechanism, blade sharpness, and rotational-speed regulation may still be improved.

Mechanical cassava starch extraction systems improve starch recovery through cell-wall rupture and continuous grating action that releases starch particles from cassava tissue. Modern cassava-processing machines can also separate fibrous residues for possible use as animal feed or organic fertilizer. The present results are supported by Sarpong et al. (2024), who stated that drum speed, clearance, and mechanical configuration influence mash consistency and liquid separation. Sarpong et al. (2024) further emphasized that improved grater design and feeding mechanisms enhance processing efficiency, while Ertebo and Koroso (2024) found that motor speed and feeding rate affect grating performance. Esteves et al. (2019) also reported that motorized cassava graters improve grating efficiency and reduce labor requirements compared with traditional methods.

3.2.2 Pressing Performance

The pressing trials also used 1 kg of cassava and 250 mL of water. Processing times ranged from 2.52 to 3.01 minutes, with a reported mean of 2.71 minutes, interpreted as "Moderately Workable." Starch output ranged from 168 g to 175 g, with a mean of 171 g. Pulp output ranged from 600 g to 610 g, with a mean of 605 g, while liquid extraction ranged from 226 mL to 240 mL, with a mean of 232 mL. In the first trial, processing required 2.60 minutes and produced 170 g of starch, 600 g of pulp, and 230 mL of liquid. The second trial required 2.52 minutes and produced the highest starch output of 175 g, the highest pulp output of 610 g, and the lowest liquid extraction of 226 mL. The third trial required 3.01 minutes and produced the lowest starch output of 168 g, 605 g of pulp, and the highest liquid extraction of 240 mL. These results indicate that the pressing function operated within an acceptable timeframe but produced some variation in output.

The variation may be related to differences in mash density, moisture content, fiber distribution, pressure application, and compression resistance. Cassava pressing depends on consistent compression force and appropriate moisture migration, while the fibrous characteristics and density of cassava mash influence dewatering efficiency and extraction uniformity. Inconsistent pressure application may cause differences in moisture extraction and processing time. The overall pressing performance was therefore workable but less consistent than the grating performance. Sarpong et al. (2024) similarly reported that prototype machines may produce inconsistent results because of non-homogeneous feedstock and mechanical integration problems between grating and pressing units. These findings support the need for further improvements in pressure uniformity, chamber stability, structural design, and mechanical coordination.

3.3 Acceptability of the Processor

3.3.1 Design Acceptability

The machine obtained an overall weighted mean of 2.96 for design, interpreted as "Acceptable." Respondents rated its innovative and functional integration of grating and pressing at 3.20, the coordination of grating and pressing at 2.16, and the incorporation of the mechanisms into the overall design at 2.16. The coordinated operation of the grating, pressing, and motor-chain system received 3.16. The space-saving structure received the highest design rating of 3.90, followed by component arrangement for smooth workflow at 3.50. Suitability for small-scale kakanin production received 3.16, structural stability received 3.20, ease of cleaning and maintenance received 2.66, and the machine's ability to meet cassava-processing needs received 2.50. The results indicate that respondents valued the machine's compactness, workflow arrangement, and general functionality. However, the relatively lower ratings for mechanism integration, maintenance accessibility, and overall processing performance indicate areas requiring improvement. The design was considered suitable for small-scale production but not yet fully optimized for continuous operation.

Integrated cassava-processing systems reduce labor intensity, improve efficiency, and shorten operating time by combining multiple functions in one machine. Adekanye et al. (2025) noted that integrated machines may experience component-synchronization and mechanical-resistance problems. Sarpong et al. (2024) emphasized that proper component arrangement improves performance, durability, workflow, and output consistency. Abama et al. (2024) reported that efficient power transmission and connected grating mechanisms improve throughput. The need to improve maintenance accessibility and overall integration is consistent with Adekanye et al. (2025) and Sarpong et al. (2024).

3.3.2 Usability Acceptability

The machine obtained an overall mean of 2.97 for usability, interpreted as "Acceptable." Ease of operation received a mean of 2.33, while clarity of operating instructions received 3.20. The grating function received 2.50, and the pressing function received 2.16. Consistency of output received 3.20 and coordinated machine operation received 3.50. The controls received the highest usability rating of 3.63. Use by beginners and experienced users received 3.26, reduction of manual effort received 3.16, and overall performance in meeting user expectations received 2.83. The results show that the machine was generally usable, particularly because of its controls, system coordination, and accessibility to different users. However, respondents identified limitations in ease of operation, grating performance, and especially pressing effectiveness. The usability findings therefore reflect acceptable functionality but indicate the need for clearer operation, improved pressing, and more consistent output.

Machine usability depends on design simplicity and reduced operator burden. Clear instructions improve user engagement and reduce operating errors. Grating efficiency is influenced by blade design, motor speed, and feed uniformity. Pressing mechanisms commonly experience inadequate pressure distribution and limited moisture-extraction efficiency. Output consistency depends on proper synchronization of machine components. Simple controls improve usability and reduce user learning time. Mechanization reduces physical workload but remains dependent on system efficiency. User satisfaction is influenced by usability, efficiency, and output reliability. Structural design, system coordination, and operational efficiency influence machine usability and performance. Efficiency, output consistency, and user-friendliness are critical factors affecting the usability and acceptance of cassava graters.

3.3.3 Convenience Acceptability

The machine obtained an overall weighted mean of 3.49 for convenience, interpreted as "Highly Acceptable." The highest rating was given to time savings, with a mean of 3.83. Respondents rated reduction of physical effort at 3.20, ease of assembly and disassembly at 3.16, ease of cleaning at 3.36, ease of storage at 3.66, convenience of the combined grating and pressing function at 3.36, continuous operation at 3.46, ease of transfer at 3.60, simplification of kakanin preparation at 3.63, and productivity enhancement at 3.66. The results indicate that convenience was the strongest aspect of the machine. Respondents particularly valued its ability to reduce processing time, save space, support mobility, simplify kakanin preparation, and improve productivity. Assembly and physical-effort reduction received comparatively lower ratings, suggesting that some manual handling and structural complexity remained.

Mechanized cassava-processing systems reduce processing time through automated grating and continuous operation. Mechanization reduces labor intensity, although manual handling may remain necessary depending on machine design and feeding arrangements. Modular design improves usability but may be limited by the complexity of integrated systems (Adekanye et al., 2025). Sarpong et al. (2024) identified ease of cleaning as important for hygiene, efficiency, and durability. Compact and portable equipment is particularly useful in small-scale production. Integrating processing activities reduces the number of operating stages and improves efficiency. Coordinated motor-driven systems support continuous operation and reduced downtime (Adekanye et al., 2025). Sarpong et al. (2024) found that mechanized processors improve food-production efficiency by integrating multiple stages. These results also support the principle of appropriate technology, which emphasizes that advances must be pragmatic, efficient, and user-friendly. Convenience, ease of handling, and labor-saving characteristics remain important factors in the acceptance of technological innovations.

3.3.4 Safety Acceptability

The machine obtained an overall mean of 3.06 for safety, interpreted as "Acceptable." Respondents rated safe operation at 3.20, reduction of injury risk at 2.16, protection of moving parts at 3.20, safety safeguards at 3.50, secure footing at 3.53, electrical insulation at 2.50, prevention of overheating at 3.20, food-processing material safety at 3.66, operation without harmful hazards at 3.16, and user safety during continuous operation at 2.50. The results indicate that the machine was generally considered safe because of its stable structure, protective features, circuit breaker, and food-appropriate materials. The highest rating concerned the safety of the materials used, while the lower ratings concerned injury prevention, electrical insulation, and safety during continuous operation. These findings show that the machine had basic safety provisions but required further improvement in guarding, electrical protection, and long-term operational safety.

Enclosed systems and structural protection are important for reducing risks during cassava processing. Inadequate integration and incomplete enclosure of moving components can create safety hazards (Sarpong et al., 2024). Guarding rotating parts helps prevent accidental contact. Automation and safety features reduce operator exposure to mechanical hazards, and structural stability prevents machine failure during operation. Electrical insulation and electrical protection are basic safety requirements for motorized food-processing equipment. Food-grade materials improve hygiene, reduce contamination risks, and support safe cassava processing. Continuous-operation safety depends on thermal control, electrical protection, and mechanical stability.

3.4 Overall Relationship Between Workability and Acceptability

The results show a relationship between the processor's technical performance and its user acceptability. The grating function was classified as "Workable," with consistent outputs and a mean processing time of 2.27 minutes. The pressing function was classified as "Moderately Workable," with a mean processing time of 2.71 minutes and greater variation in starch, pulp, and liquid outputs. In the user evaluation, the machine was "Acceptable" in design, usability, and safety, while convenience was "Highly Acceptable."

The findings suggest that the machine's strongest user-perceived benefit was convenience, particularly because the integrated design reduced processing stages, saved time, supported mobility, and reduced manual effort. However, the lower pressing performance and moderate ratings for system integration, ease of operation, maintenance, injury prevention, electrical insulation, and continuous-operation safety indicate that technical improvements are still necessary. Overall, the machine demonstrated practical functionality and user value, but improvements in pressure application, mechanical stability, component integration, maintenance access, and safety protection would strengthen its performance and long-term acceptability.

4. Conclusion & Recommendations

The study successfully designed, constructed, tested, and evaluated a 2-in-1 cassava processor for small-scale kakanin production. The machine performed "Workable" in grating, with a mean processing time of 2.27 minutes and relatively consistent starch, pulp, and liquid outputs. Its pressing function was classified as "Moderately Workable," with a mean processing time of 2.71 minutes and some variation in extraction performance caused by starch adhesion, mash characteristics, pressure distribution, and mechanical limitations. The use of water, a presser plate, and a press cage improved material flow and pressing efficiency. The processor was rated "Acceptable" in design, usability, and safety, and "Highly Acceptable" in convenience, indicating that it was functional, practical, user-friendly, and capable of reducing processing time and manual effort for small-scale cassava processing.

The 2-in-1 cassava processor should be further improved, particularly in the integration and coordination of the grating and pressing mechanisms, pressure application, extraction efficiency, structural stability, feeding mechanism, blade sharpness, motor performance, maintenance accessibility, injury prevention, electrical insulation, and safety during continuous operation. The use of water during operation, together with the presser plate and press cage, should be maintained as part of the revised pressing system. Further testing and refinement should focus on improving output consistency, reducing starch adhesion and mechanical vibration, and enhancing the machine's reliability, usability, safety, and long-term performance in small-scale cassava and kakanin production.

5. Compliance with ethical standards

The study underwent ethics review and secured authorization before data collection. Respondents were informed of the study's purpose, participated voluntarily, and were assured that their responses would remain confidential and be used solely for academic purposes. The questionnaire was validated by three experts, and no identifying or sensitive participant information was disclosed.

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