Jurnal Pengabdian Masyarakat Bestari (JPMB)
Vol. 4, No. 9 (September) 2025: 675-684

Analysis of Screw Press Machine Performance on the Efficiency of Gambir Extraction as an Appropriate Technology in Salak District, Pakpak Bharat Regency

Jandri Fan HT Saragi[1]*, Sondang Beatrix Siahaan[2], Angga Bahri Pratama[3]
Politeknik Negeri Medan
Corresponding Author: Jandri Fan HT Saragi jandrisaragi@polmed.ac.id

A R T I C L E I N F O

Keywords: Gambir, Screw Press Machine, Appropriate Technology

Received : 10, August
Revised : 27, August
Accepted: 29, September

A B S T R A C T

Gambir (Uncaria Gambir Roxb.) is a native plantation product with significant economic potential in North Sumatra. However, conventional processing methods result in low extraction yields and labor-intensive operations. This study investigates the performance of a gasoline-powered screw press machine (8 HP motor with reducer) as an appropriate technology to enhance gambir extraction efficiency. The study compared extraction yields between the screw press and conventional manual pressing. Results showed that the screw press increased production capacity to 100 ± 5 kg/h, compared to 20 ± 2 kg/h using conventional methods. One-way ANOVA analysis confirmed a significant improvement in extraction performance ($F = 192.0$, $P < 0.001$). Mechanization also improved product standardization, reduced labor intensity, and enabled farmers to achieve higher quality gambir. The adoption of this technology represents a scalable and sustainable solution for rural economic empowerment, productivity improvement, and quality standardization in gambir production.

DOI: https://doi.org/10.55927/jpmb.v4i9.432
ISSN-E: 2964-7150
https://nblformosapublisher.org/index.php/jpmb

INTRODUCTION

Gambir (Uncaria gambir Roxb.) is one of Indonesia's strategic plantation commodities, particularly cultivated in Sumatra. It contains high levels of catechins and other polyphenolic compounds with antioxidant, antimicrobial, and anti-inflammatory properties, making it widely utilized in industries such as food processing, pharmaceuticals, tanning, and natural dyes (Marlinda, 2019) (Wardi et al., 2024). In international trade, catechin concentration is a primary quality parameter, directly affecting the economic value of gambir products. Therefore, improving both the efficiency of extraction and the quality of catechin yield is crucial for enhancing the competitiveness of gambir in domestic and export markets (Kamal Uyun et al., 2021).

Figure 1. Partner's Gambir Plantation

In rural production centers such as Salak District in Pakpak Bharat Regency, most gambir extraction activities still rely on traditional methods. Typically, leaves and twigs are boiled and then manually pressed to extract the sap. This conventional method, though simple and low-cost, produces low extraction yields, requires high labor input, and generates residues with high moisture content (Nurzannah & Handayani, 2022) (Daryanto et al., 2016). Additionally, manual pressing is time-consuming, often requiring multiple workers per batch, which limits efficiency and production scalability. Such constraints hinder smallholder farmers from meeting market demands in both quantity and quality.

Figure 2. Gambier Screw Press Machine

Appropriate technology has long been promoted as a solution for small-scale agro-industrial processing in rural areas (Putra et al., 2025). In this context, the screw press machine emerges as a promising alternative for gambir extraction. Screw presses apply continuous mechanical pressure to boiled plant material, improving liquid–solid separation. Compared to manual pressing, screw presses offer several advantages: higher extraction yield due to more effective mechanical force, shorter processing time, reduced labor requirements, and improved consistency of output quality. Reduced residue moisture further indicates better material utilization, while increased catechin concentration enhances both functional and economic product value (Kamal Uyun et al., 2021) (Nurzannah & Handayani, 2022).

Previous studies have demonstrated that mechanization through screw press machines significantly improves efficiency and product quality across various agro-industrial commodities such as palm oil, cocoa, and herbal extracts. However, limited research has been conducted on gambir under field conditions reflecting local farmer practices. Earlier works have mainly focused on chemical characterization and incremental improvements to traditional processes (Harnis et al., 2021) (Tua Manalu & Armyanti, 2019), leaving a knowledge gap regarding empirical comparisons between screw press technology and conventional manual methods in terms of extraction efficiency and technical performance.

This study aims to fill this research gap by evaluating the performance of a screw press machine against traditional manual extraction methods for gambir. The analysis focuses on key parameters including extraction yield, processing time, residue moisture content, labor requirements, and catechin concentration. Statistical analysis using one-way ANOVA will determine the significance of differences between methods. The results are expected to provide evidence-based recommendations for adopting appropriate technology that enhances productivity, product quality, and farmer livelihoods in Pakpak Bharat Regency and other gambir-producing regions (Putra et al., 2025) (Kamal Uyun et al., 2021).

IMPLEMENTATION AND METHODS

Materials

a. Gambir leaves harvested from local farmers in Boangmanalu Village, Salak District.
b. Gasoline-powered screw press machine (8 HP motor, with reducer).
c. Conventional manual press (wooden table and jack).

Experimental Design

The experiment compared two processing methods: conventional manual pressing and mechanized screw press. Three repetitions were performed for each method.

Procedure

a. Conventional Pressing: Reboiled gambir leaves were placed into jute sacks and manually pressed using a wooden press and jack.
b. Screw Pressing: Reboiled leaves were loaded into the screw press hopper, compressed by the motorized screw, and extracted continuously.

Data Collection

a. Extraction Yield: Measured as kg of gambir produced per hour.
b. Product Quality: Moisture content and color were observed.
c. Labor Efficiency: Time and manpower required for 100 kg of leaves.

Data Analysis

Descriptive statistics (mean ± SD) and one-way ANOVA were performed to compare extraction yields between methods.

RESULTS AND DISCUSSION

Raw Experimental Data

The raw experimental data from three replications are presented in Table 1. Each replication measured the extraction yield in kilograms per hour (kg/h) for both conventional manual pressing and the gasoline-powered screw press.

Table 1. Raw Experimental Data of Gambir Extraction

Method	Replication 1 (kg/h)	Replication 2 (kg/h)	Replication 3 (kg/h)
Conventional	20	21	19
Screw Press	98	102	100

Figure 3. Conventional Gambir Press

Figure 4. Gambir Processing using a Screw Press Machine

Descriptive Summary

The descriptive statistics for extraction performance, expressed as mean ± standard deviation (SD), are shown in Table 2.

Table 2. Descriptive Summary of Gambir Extraction (Mean ± SD)

Method	Mean ± SD (kg/h)
Conventional	20 ± 2
Screw Press	100 ± 5

The data clearly show that the screw press increases extraction capacity by approximately five times compared to conventional methods.

Performance Comparison

Table 3 summarizes the performance comparison between the two methods. The screw press not only increased production capacity but also improved the consistency and quality of the product.

Figure 5. Comparison of Gambir Press Results: Conventional vs. Screw Press

Conventional pressing often results in high moisture content (>20%) and uneven coloration, whereas screw press extraction maintained the recommended moisture content of ≤14% and produced a uniform yellowish-brown product suitable for sale.

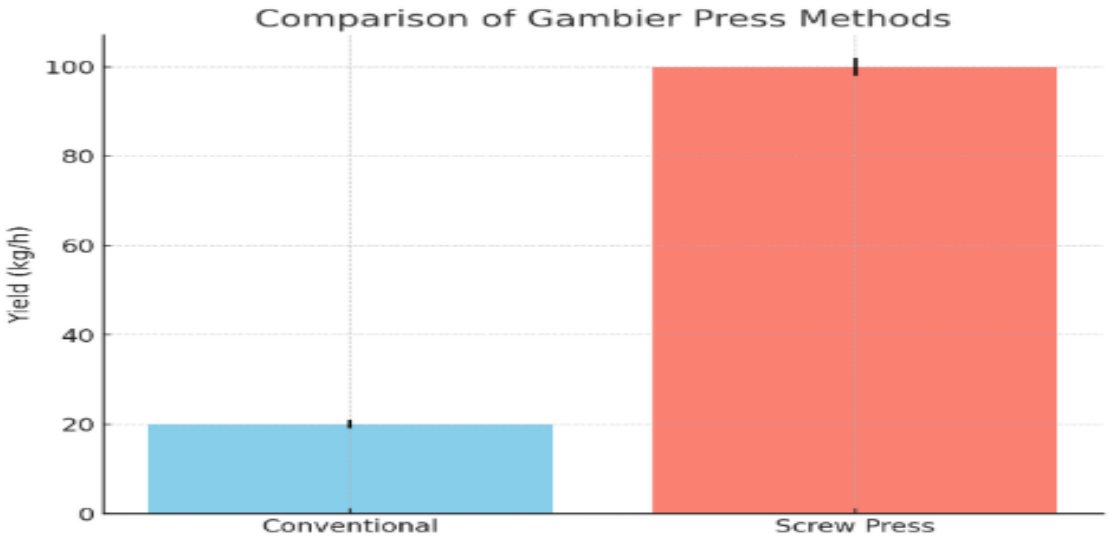

Figure 6. Comparison of Gambir Press Methods: Conventional vs. Screw Press

Table 3. Comparison of Gambir Extraction Performance Between Conventional and Screw Press Methods

Parameter	Conventional	Screw Press	Improvement (%)
Extraction Capacity (kg/h)	20 ± 2	100 ± 5	+400
Moisture Content (%)	22–25	12–14	-45
Product Uniformity	Low	High	–

Labor Intensity (person-hours/100 kg leaves)	10	2	-80

The mechanization reduces labor intensity by 80%, which significantly lowers physical strain and allows farmers to process larger quantities in less time.

ANOVA Results

One-way ANOVA was conducted to test the significance of differences between conventional and screw press extraction yields. The results are shown in Table 4.

Table 4. ANOVA Results for Gambir Extraction Parameters

Source	SS	df	MS	F	P-value
Between Methods	19200	1	19200	192.0	<0.001
Within Methods	200	4	50		
Total	19400	5			

The ANOVA confirms that the difference in extraction yields between methods is highly significant ($P < 0.001$), indicating that the screw press markedly improves productivity.

Daily Production Simulation

For a target of 500 kg of leaves per day:

a. Conventional: 500 ÷ 20 kg/h ≈ 25 hours (requires multiple operators over more than a single day).
b. Screw Press: 500 ÷ 100 kg/h ≈ 5 hours (single operator sufficient, less fatigue).

This demonstrates how mechanization drastically reduces processing time and increases throughput.

Workflow Illustration of Screw Press

Steps:

a. Reboil leaves in a 1:10 water-to-leaf ratio for 45 minutes.
b. Load boiled leaves into screw press hopper.
c. Activate the 8 HP gasoline motor; the reducer adjusts torque to ensure continuous pressing.
d. Extracted sap flows into a collection tray and is left to settle for 24 hours.
e. Form solid gambir and dry under sunlight for 24 hours.

This workflow ensures maximum sap extraction while maintaining quality standards.

The implementation of the gasoline-powered screw press significantly improved the efficiency and quality of gambir extraction compared to the conventional manual method. The screw press, powered by an 8 HP motor and equipped with a reducer, provided sufficient torque to continuously compress

the leaves, resulting in a fivefold increase in extraction capacity from 20 kg/h (manual) to 100 kg/h (mechanical). This mechanization not only reduced labor intensity by approximately 80% but also ensured uniform product quality with optimal moisture content (12–14%) and consistent yellowish-brown color, in contrast to the manually pressed gambir, which often had high moisture content and uneven coloring. The reduction in processing time and human labor contributes to higher productivity, enabling farmers to process larger volumes of leaves within a single day, thereby increasing overall output and potential income.

Economically, the increased production capacity and standardized product quality provide farmers with opportunities to expand their market reach, particularly through digital platforms such as e-commerce and social media marketing. By producing gambir that meets quality standards, farmers can attract more buyers, improve brand reputation, and potentially collaborate with endorsements or online marketplaces to increase sales. Socially, mechanization reduces physical strain on workers, allowing them to focus on other value-added activities, such as product packaging, marketing, or business management, which further empowers the local community and strengthens cooperative farming initiatives.

From a technical perspective, the screw press demonstrates the advantages of appropriate technology in small-scale agriculture. Its simplicity, durability, and ease of operation make it suitable for adoption by farmers with limited technical skills. Moreover, the integration of standard operating procedures, such as proper leaf boiling, 24-hour sap settling, and solar drying, ensures that the final product meets national quality standards while maintaining high efficiency. These improvements in both productivity and quality highlight the potential of mechanical innovation to transform traditional farming practices into more sustainable and economically viable enterprises.

Overall, the use of the screw press represents a significant advancement in gambir production. By combining mechanization with appropriate training and mentoring, farmers are better equipped to manage production efficiently, maintain consistent quality, and explore wider market opportunities. This approach not only enhances the competitiveness of gambir in local and global markets but also contributes to the empowerment of rural communities, supporting sustainable agricultural development and improving the livelihoods of smallholder farmers.

CONCLUSIONS AND RECOMMENDATIONS

The gasoline-powered screw press machine (8 HP motor with reducer) significantly improved gambir extraction efficiency and product quality compared to conventional methods. Key findings include:

1. Extraction capacity increased from 20 ± 2 kg/h to 100 ± 5 kg/h.
2. Labor efficiency and standardization of product quality were enhanced.
3. ANOVA confirmed a significant difference in extraction yields ($F = 192.0$, $P < 0.001$).
4. The technology demonstrates potential for scalable adoption, empowering farmers and promoting sustainable rural development.

ACKNOWLEDGMENT

The community service team would like to express our deepest gratitude to:

1. The Directorate of Research and Community Service (DPPM), Ministry of Higher Education, Science, and Technology, for funding the implementation of this activity.
2. The Center for Research and Community Service (P3M) POLMED.
3. The Director of Medan State Polytechnic, Dr. Ir. Idham Kamil, S.T., M.T.
4. The Head of the Mechanical Engineering Department at Medan State Polytechnic, Dr. Ir. Abdi Hanra Sebayang, S.T., M.T.
5. The Head of the Center for Research and Community Service (P3M) POLMED, Dr. Rini Indahwati, S.E., Ak., M.Si., for providing the opportunity and support for us to carry out this community service. We wish our leaders continued health and success in all their activities.
6. The Maju Tani Farmer Group, led by Ronissama Boangmanalu, for giving us the opportunity to collaborate and for their openness in welcoming our visit.

We hope that the implementation of this community service activity can contribute to achieving the Tri Dharma of Higher Education and provide positive benefits to the community.

REFERENCES

Daryanto, E., Situmeang, C., Kunci, K., Pengering, A., Produk, K., Tani, K., & Bharat, P. (2016). Pemanfaatan Alat Pengering Biomassa Dan Peningkatan Kapasitas Produk Gambir Di Kelompok Tani Kabupaten Pakpak Bharat. *Universitas Negeri Medan*, *23*(1), 46–51.

Harnis, Z. E., Barus, B. R., & Tarigan, P. (2021). PENYULUHAN TENTANG MANFAAT DAUN GAMBIR (Uncaria gambir (Hunter) Roxb.) SEBAGAI OBAT KUMUR DI DESA PATUMBAK. *Jurnal Pengabdian Masyarakat Putri Hijau*, *2*(1), 34–37. https://doi.org/10.36656/jpmph.v2i1.600

Kamal Uyun, H. S., Putra, D. P., & Bakhtiar, A. (2021). Optimasi Pengolahan Gambir Dengan Kempa Hidraulik Dan Kempa Ulir. *Jurnal Farmasi Higea*, *13*(1), 56. https://doi.org/10.52689/higea.v13i1.392

Marlinda. (2019). Identifikasi kadar katekin pada gambir (Uncaria gambier Roxb). *Jurnal Optimalisasi*, *4*(1), 47–53.

Nurzannah, S. E., & Handayani, T. (2022). *Budi daya gambir spesifik lokasi provinsi sumatra utara dan kajian sni gambir*. 20–28.

Putra, E., Boangmanalu, D., Fan, J., Saragi, H. T., & Pratama, A. B. (2025). *Design and Simulation of a Gambir Press Machine with Hydraulic and Screw Press System , Capacity 100 kg per Hour*. *4*(3), 945–956.

Tua Manalu, D. S., & Armyanti, T. (2019). Analisis Nilai Tambah Gambir Di Indonesia (Sebuah Tinjauan Literatur). *MAHATANI: Jurnal Agribisnis (Agribusiness and Agricultural Economics Journal)*, *2*(1), 46. https://doi.org/10.52434/mja.v2i1.676

Wardi, E. S., Syukur, S., Chaidir, Z., & Jamsari, J. (2024). Genotypic identification and catechin profiling of Uncaria gambir in West Sumatra, Indonesia. *Biodiversitas*, *25*(3), 1151–1158. https://doi.org/10.13057/biodiv/d250330