Terbit *online* pada laman web jurnal : http://metal.ft.unand.ac.id

METAL: Jurnal Sistem Mekanik dan Termal

| ISSN (Print) 2598-1137 | ISSN (Online) 2597-4483 |

Research article

Innovation of a Shallot Peeling Machine Based on Appropriate Local Resource Technology to Improve the Production Efficiency of Household Industries

Abdul Salam[1a], Nurhidayanti[2a], Muhammad Jayadi[3b], Zahra Fatin[4b]*

[a]*Department of Mechanical Engineering, Politeknik Negeri Ujung Pandang, 90245, Sulawesi Selatan, Indonesia*

[b]*Department of Accounting, Politeknik Negeri Ujung Pandang, 90245, Sulawesi Selatan, Indonesia*

ARTICLE INFORMATION

Article History:
Received : 10 October 2025
Revised : 02 December 2025
Accepted : 30 April 2026

KEYWORDS

Appropriate technology
Shallot peeling machine
Rotational speed
Efficiency
Productivity

CORRESPONDENCE

E-mail: abdsalam@poliupg.ac.id

A B S T R A C T

Household industries engaged in shallot processing in Kapasa Raya, Makassar, face productivity constraints due to manual peeling methods that are time-consuming and labor-intensive. To address these challenges, an appropriate technology innovation was introduced through the design and implementation of a shallot peeling machine that is simple, ergonomic, and tailored to local needs. The research involved several stages, including field surveys, design in Fusion 360, fabrication, assembly, and performance testing. The test results indicated that the optimal parameter combination, a machine rotation speed of 112 rpm, a capacity of 2.5 kg, and a peeling duration of 2 minutes with hot water soaking, was able to achieve an efficiency of up to 37.5 kg/hour. This innovation not only accelerates peeling and reduces operator fatigue but also maintains shallot visual quality, thereby enhancing the competitiveness of MSME products. The adoption of this machine has had significant technical and socio-economic impacts on small-scale business operators.

1. INTRODUCTION

Shallots *(Allium cepa L. var. aggregatum)* are among the most important horticultural commodities in Indonesia, valued for their high economic value and significant contribution to national food security. Apart from being a staple seasoning in almost all traditional Indonesian dishes, shallots also serve as a major source of farmers' income and as a raw material for the food industry, particularly for fried shallot products [1].

According to data from the Central Bureau of Statistics (BPS) and the Directorate General of Horticulture, shallot production in South Sulawesi increased substantially between 2019 and 2023. In 2023, the province contributed 201,421 tonnes from a harvested area of 16,441 hectares, ranking it among Indonesia's key production centers [2]. This indicates a strong upstream potential for shallots, both as fresh commodities and as processed products.

The growth of Micro, Small, and Medium Enterprises (MSMEs) also plays a crucial role in the shallot processing industry. Processed products such as fried shallots are of high economic value, widely consumed, and considered a potential source

https://doi.org/ 10.25077/metal.10.1.28-35.2026

of foreign exchange [3]. The food processing sector has demonstrated steady growth in Indonesia, spanning large enterprises to home-scale operations. Among the various processed food products available on the market, fried shallots stand out for their high consumer demand and culinary appeal [4]. These products are not only used in household cooking but are also widely used in restaurants and modern culinary businesses [5].

In urban areas such as Makassar, demand for processed food continues to rise alongside population growth and lifestyle changes. However, this great potential is not adequately supported by technology in many MSMEs. For example, partner MSMEs in Makassar have relied on manual peeling for more than a decade. This conventional method is highly time-consuming, requires large numbers of workers, and causes physical fatigue, thereby limiting production capacity and business efficiency. It also hampers MSMEs' ability to meet increasing market demand. Baskara et al. (2018) found that manual peeling can reduce productivity by up to 40% compared with mechanical peeling [6].

In the partner MSMEs, shallot peeling was entirely performed manually using knives and bare hands. To process 350 kg of shallots, approximately 10 workers are required for 3,180 minutes (53 working hours). Such conditions not only absorbed a substantial labor force but also forced extended working hours, which added to fatigue and lowered overall productivity.

To overcome this issue, the application of Appropriate Technology (AT) has become a strategic step. AT refers to technological innovations designed to meet field requirements, simple to operate, cost-efficient, and capable of improving production efficiency [7]. Previous studies have demonstrated that AT can increase productivity, reduce operational costs, and strengthen MSMEs' independence [8]. One relevant innovation is the development of a shallot peeling machine with a simple yet effective design.

Numerous studies have highlighted the urgency of such innovation. Nurchaya et al. (2021) designed a small-scale shallot peeling device with a capacity of 1 kg, showing that motor speed directly influences peeling quality, with 400 rpm performing better than 300 rpm and 500 rpm [9]. Nor Ali Aziz et al. (2024) reported that peeling machines can increase efficiency by up to 70% compared to manual methods [10], while Susanto & Yunus (2020) noted that simple machines can reduce labor requirements by up to 50% and improve peeling quality [11]. Yudhana et al. 2023 further demonstrated that rotary drum or mechanical blade systems accelerate peeling by three to five times compared with traditional methods [12]. These findings confirm the significance of adopting similar innovations in MSMEs in Makassar.

Beyond technical improvements, AT also generates socio-economic impacts. Shallot peeling machines can expand market reach, enhance product competitiveness, and create new job opportunities. Thus, the innovation of appropriate technology serves not only as a technical solution but also as a tool for community empowerment and strengthening local economies.

Based on this background, the present article discusses the implementation of appropriate technology innovation in the form of a shallot peeling machine for MSMEs in Makassar. The aim is to address the low productivity caused by manual methods while emphasizing the technology's suitability to local partners' needs, ease of use, and its contribution to efficiency, economic value, and business independence.

2. METHOD

This study adopted an appropriate technology engineering approach to design and implement a shallot peeling machine tailored to the needs of MSMEs. The methodology involved several structured stages:

2.1. Design Concept

The initial design of the machine was carried out using Fusion 360 software [13]. The design considered the dimensions of local shallots, MSME production capacity, and ease of maintenance. Three-dimensional modeling and mechanism simulations were conducted to evaluate the smooth operation of the peeling system. Ergonomic principles were incorporated in line with the systematic design approach of Pahl and Beitz (1996) [14] and with user-oriented product development as described by Ulrich and Eppinger (2016) [15].

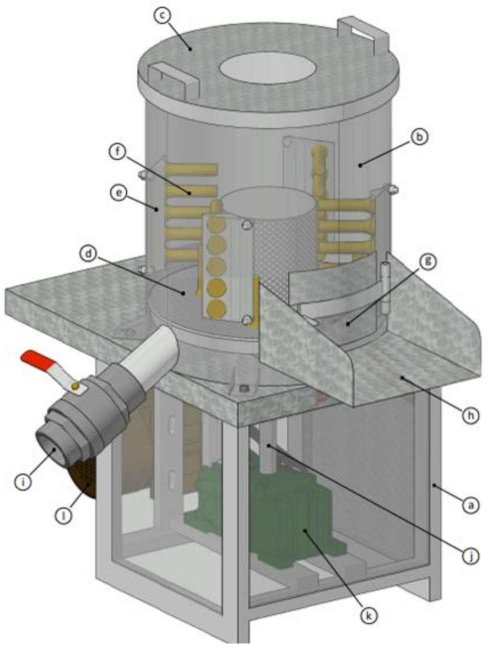

Figure 1. Machine Design Concept.

The design comprised six primary components: the frame, peeler, drive system, disposal unit, cover, and auxiliary parts. The frame provided structural support, while the peeler served as the core element for skin removal. The drive system utilized an electric motor, pulleys, a gearbox, and a V-belt to transmit power to the shaft and peeling drum. During operation, the shallots rotated inside the drum, were lifted to the top, and then fell back under gravity, creating friction between the shallots and the peeling surface that effectively loosened the skins.

2.2 Manufacturing of the AT Machine

Once the design is approved, the machine is manufactured using readily available local materials. Calculations for machine elements, such as shafts, bearings, and power transmission components, are carried out according to the principles outlined in Basics of Machine Element Planning and Selection by Sularso (2004) [16].

2.2.1 Motor drive calculation

Power of the driving motor, where in:

$$P = \frac{F_s \cdot V_s}{4500} \qquad (1)$$

F_s = mass of the disc + mass of the axle + mass of the onion + mass of water + mass of the pulley + mass of rubber + mass of the wing + mass of the tube. That is the equation. $F_s = 1.2\text{kg} + 1.1\text{kg} + 2\text{kg} + 2.5\text{kg} + 0.7\text{kg} + 0.1\text{kg} + 0.4\text{kg} + 0.6\text{kg} = 8.6\text{kg}$. The motor rotation is 1400 rpm, and a shaft diameter of 35 mm is used, so that its speed:

$$V_s = \frac{\pi \cdot ds \cdot n}{1000} \qquad (2)$$

$$= \frac{3.14 \times 35 \times 1400}{1000}$$

$$= 153 \text{ rpm}$$

Thus , the motor power used is:

$$P = \frac{F_s \, . \, V_s}{4500}$$

$$P = \frac{8.6 \text{ x } 153}{4500} = 0.29 \text{ kW}$$

Design power, $P_d = $ P x Fc = 0.29 x 1.2 = 0.348 kW. Unit non-metric power: 1 HP = 0.7475 kW. Then, for power, 0.384 kW = 0.465 HP. So the motor power required by the machine is 0.5 HP.

2.2.2 Calculation of shaft rotation and belt length

In this design, a pulley ratio of 4” and 2.5” is used with a 1:20 reducer.

$\frac{n_2}{n_1} = \frac{d_1}{d_2}$, $n_2 = \frac{n_1 \cdot d_1}{d_2}$ where in $d_1 = 101.6$ mm; $d_2 = 63.5$ mm; $n_1 = 1400$ rpm; gear ratio 1:20 then $n_2 = \frac{(1400:20) \, x \, 101.6}{63.5} = 112$ rpm. Data $r_1 = 31.75$ mm $r_2 = 50.8$ mm x = 320 mm, then the belt length is obtained,

$$L = [\pi(r_1 + r_2) + 2x] + \frac{(r_2 - r_1)^2}{x}$$

with r_1 = 31.75 mm, r_2 = 50.8 mm, x = 320 mm, we obtain: L = 899.9 mm ≈ 35.43 in.

2.2.3 Calculation of shaft diameter

In this design, the shaft material is ST 42, with a tensile strength of 420 kg/mm^2. On this shaft, the loads are bending and torsional. Based on the calculations obtained torsional moment Mp = 112.5 Nm , Bending moment M1 = 104.31 Nm , Allowable shear stress τ_g = 84 kg/ mm^2, then the shaft diameter

$$D = \left[\frac{5{,}1}{tg}\sqrt{(Km\,.\,Mb)^2 + (Kt\,.\,T)^2}\right]^{\frac{1}{3}}$$

= 26.35mm (kondisi aman yaitu diameter 35 mm)

2.2.4 Calculation of joint strength

In this design, the most critical part is the type of welding electrode used, which is E 6013, with a maximum tensile strength of 60,000 psi (414 N/mm^2). Where in, τ_g is shear stress (N/mm^2); T, namely, is welding thickness (mm); F is load (N); and then N is safety factor. Thus, the shear stress that occurs:

$$\tau_g = \frac{F}{0{,}707\,.\,T\,.\,L\,.\,N}$$

= 24.399 N/ mm^2 (24.399 N/mm^2 < 414 N/mm^2 thus the design of welds on critical frames is safe.

2.4 Machine Assembly

The manufactured components are assembled according to the designed work sequence. This stage ensures that all components are optimally integrated and operate normally.

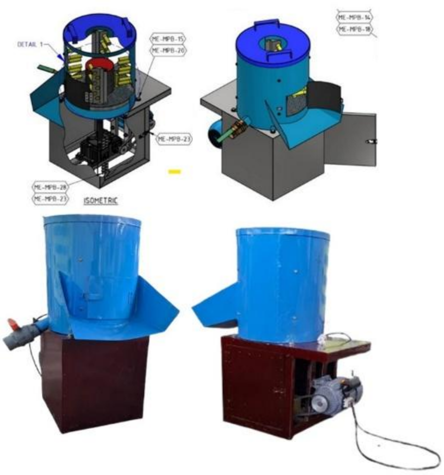

Figure 2. Shallot Peeling Machine.

2.5 Machine Feasibility Testing

The assembled machine was tested to ensure optimal peeling performance. Testing included peeling efficiency (number of onions peeled per minute), material damage rate, operator convenience, and energy consumption. Repeated trials were conducted to determine the optimal peeling rotation speed for the machine. Feasibility evaluation in product development, as described by Jamnia 2020 [17], involves repeated testing and design refinement.

Figure 3. Feasibility Testing of Onion Peeling Machine Development.

2.6 Test Data Analysis

Test data was analyzed quantitatively to assess machine performance. Parameters analyzed included peeling yield, peeling time, and the number of onions peeled.

3. RESULT AND DISCUSSION

Test results show that the effectiveness of the shallot peeling machine is significantly influenced by a combination of engine speed, material weight, peeling time, and pretreatment. This finding reinforces the principles of user-driven design and production efficiency.

Table 1. Test Results Data for Peeling Red Onions on 1 kg without Soaking

Rotation speed (rpm)	Peeling Time (minutes)	Peeling Results
196	1	Not perfect, the onion skin has not been completely peeled off
	2	Peeled perfectly, the surface of the onion flesh is even
	3	Peeled, the surface of the onion flesh shows the white core of the onion.

 https://doi.org/ 10.25077/metal.10.1.28-35.2026

(a) Peeling results for 1 minute (b) Results of peeling for 2 minutes (c) Results of peeling for 3 minutes

Figure 4. Results of peeling 1 kg of shallots at 196 rpm.

The results of the onion peeling machine test at 196 rpm, without soaking, showed a significant effect of process length on peeling quality. In Figure 4(a), with a peeling duration of 1 minute, the peeling is not perfect because much onion skin remains attached. This indicates that the short time is insufficient to achieve optimal friction between the onion and the peeling component. In Figure 4(b), over a 2-minute duration, the onion skin is peeled well, and the onion surface appears even with minimal damage. This condition can be considered the ideal result because the peeling is effective and clean while still maintaining the onion's visual quality. However, in Figure 4(c), at a peeling time of 3 minutes, although the peeling is perfect, the surface of the onion flesh begins to appear damaged, and even the core appears white because the outer layer has been peeled. This damage reduces the onion's appearance, making it less suitable for processed product standards, especially at the MSME scale, where visual quality is prioritized.

Based on the test results shown in Table 1, these findings align with Pandu Annanto & Budi Astuti (2022), who state that high speed can indeed accelerate the peeling process. Still, it must be controlled to prevent damage to the material [18]. This is especially important for MSMEs, where product visual quality is a key factor in attracting consumers. Therefore, these test results confirm that the combination of rotation speed and peeling time must be well controlled to achieve a balance between work efficiency and peeling quality.

Table 2. Test Results Data for Peeling of Shallots on 2 kg with Soaking

Rotation speed (rpm)	Peeling Time (minutes)	Soaking Media	Peeling Results
84	1.5	Plain water	Some of the onion skin peeled off, but there was still a lot left.
	1.5	Hot water	The more onion skin is peeled off, the cleaner the result compared to plain water.
	2	Plain water	Peeling is better, but there is still some skin left, quite even
	2	Hot water	Optimal and even peeling results

1.5 minutes of plain water 1.5 minutes of hot water 2 minutes of plain water 2 minutes of hot water

Figure 5. Results of peeling 2 kg of shallots at 84 rpm with soaking.

Based on the test results in Table 2, it can be seen that the quality of shallot peeling is clearly different, influenced by the soaking media and the process length at a rotation speed of 84 rpm with a shallot weight of 2 kg. Figure 5(a) shows the peeling condition at 1.5 minutes in ordinary water-soaking media. The onion skin is only partially peeled, leaving much of it intact, suggesting low effectiveness. When using hot water for the same time, the peeling results are cleaner than with ordinary water, as shown in Figure 5(b), indicating that hot-soaking media accelerates skin removal.

Meanwhile, with a 2-minute increase in peeling time using plain water, as shown in Figure 5(c), more even results were achieved, although some skin remained. However, in contrast, the hot-water-soaking condition in Figure 5(d) with a peeling time of 2 minutes yielded the most.

optimal peeling results, with almost all the skin peeled evenly (homogeneously).

These findings indicate that hot or boiling water can soften shallot skin, making mechanical peeling more effective. This is in line with Maghfurah et al. (2020) 's statement that hot soaking can weaken the bonds of the outer skin of onions, thus facilitating mechanical processing and increasing peeling efficiency [19]. In addition, the duration of peeling also plays an important role, as Nurchaya et al. (2021) stated that the combination of time and rotation speed greatly affects the results of clean, even peeling without damaging the onion flesh [9].

Table 3. Test Results Data for Peeling Red Onions on 2.5 kg without Soaking

Rotation speed (rpm)	**Peeling Time (minutes)**	**Peeling Results**
112	1.5	Some of the onion skin peeled off, but there was still a lot of skin left on it
	2	The peeling results are even, the onion looks cleaner from the skin
	2.5	The peeling was fairly even, but some of the onions looked damaged from the friction.

(a) Peeling results for 1.5 minutes (b) Peeling results for 2 minutes (c) Peeling results for 2.5 minutes

Figure 6. Results of peeling 2.5 kg of shallots at 112 rpm.

Testing shallot peeling at 112 rpm without soaking showed that peeling duration directly affected peeling quality. At 1.5 minutes, the onions were only partially peeled, with much skin remaining, indicating that friction was not optimal. At 2 minutes, the peeling appeared more even and cleaner, suggesting that increasing the time could improve the friction between the onions and the peeling component. However, when the duration was increased to 2.5 minutes, although the peeling results were quite even, some onions began to show damage from excessive friction.

This indicates that without soaking, the optimal peeling time is around 2 minutes, as this duration produces clean, even peeling without causing significant damage. This result aligns with the findings of Nurchaya et al. (2021), which emphasize the importance of balancing rotation speed and peeling time to achieve optimal results [9]. In addition, research by Ghanem et al. (2020) showed that the efficiency of onion peeling machines is influenced by belt rotation speed and onion size, with the right combination of parameters increasing efficiency while maintaining onion quality [20]. Thus, both previous research and the results of this test confirm that mechanical factors (rpm and duration) are key variables that determine the success of the peeling process.

Meanwhile, in the test with a weight of 2.5 kg and a rotation of 112 rpm, peeling for 2 minutes yielded quite optimal results. However, peeling for 2.5 minutes resulted in excessive erosion, leaving the white part of the onion visible. This indicates that the peeling duration must be adjusted to the material's capacity and the machine's speed to avoid product damage. Buntoro et al. (2025) showed that peeling shallots after soaking was more effective, reaching 67.2% compared to 44.8% without soaking [21]. In addition, motor power consumption was more stable and more efficient in soaked onions, indicating that pretreatment not only improves peeling quality but also increases energy efficiency during machine operation.

Compared to the manual method, which requires 3180 minutes (53 working hours) to peel 350 kg of shallots, the use of a peeling machine with optimal parameters (112 rpm, 2.5 kg capacity, 2 minutes duration, hot water immersion) only requires about 560 minutes or 9.3 hours for the same capacity. Thus, there is a ±83% time savings and a significant reduction in human labor. In addition, in terms of labor, the manual process requires 10 workers, whereas this machine requires only 1-2 operators. This difference shows that the shallot peeling machine has the potential to reduce labor costs while substantially increasing production efficiency.

Overall, the optimal operating parameters for the shallot peeling machine were achieved at a material capacity of 2.5 kg, a machine speed of 112 rpm, and a peeling time of 2 minutes. Pretreatment with hot water soaking significantly improved peeling quality, resulting in evenly peeled skin without damaging the flesh.

Assuming each peeling cycle requires approximately 2 minutes for material input and output, the total time per work cycle is 4 minutes. Based on this assumption, the actual production capacity of the machine can be calculated as follows:

$$\frac{60}{4} \times 2.5 = 37.5kg/jam$$

This combination of parameters yields an efficient, stable peeling process that preserves shallot quality. This aligns with the principles of appropriate technology, which emphasize operational efficiency, technical sustainability, and adaptability to local conditions and the needs of MSMEs.

These findings demonstrate the potential for significant productivity increases compared to manual peeling methods, which generally require more time and labor. The study by Dwy et al. (2025) also confirmed that optimizing the machine's operating parameters, particularly rotation speed and material pretreatment, can increase peeling effectiveness while reducing overall energy consumption and labor time [4]. Therefore, this machine has the potential to be a viable solution for small- to medium-scale shallot processing MSMEs.

4. CONCLUSION

The implementation of appropriate technological innovation, such as a shallot peeling machine, has proven effective in increasing the production efficiency of MSMEs in Kapasa Raya, Makassar. The machine, designed with an ergonomic approach and tailored to local needs, can speed up the peeling process, reduce operator fatigue, and maintain shallot visual quality. Test results show that the optimal working parameters are a machine speed of 112 rpm, a capacity of 2.5 kg, and a peeling duration of 2 minutes with hot water immersion, resulting in a production capacity of up to 37.5 kg/hour. This innovation not only has a technical impact but also enhances the competitiveness and independence of MSMEs. Thus, this machine is a suitable solution for small- to medium-scale shallot processing.

5. ACKNOWLEDGEMENT

The implementation team would like to thank the Ministry of Education, Science, and Technology, through the Directorate of Research, Technology, and Community Service (DRTPM), for providing the opportunity and funding for this community service activity. They also thank the Head of UPPM, the Head of the Mechanical Engineering Department, and the Head of the Mechanical Workshop at Ujung Pandang State Polytechnic for allowing the use of their facilities to support this activity.

REFERENCES

[1] S. N. Sofyan dan Z. Sitorus, "Implementasi Data Mining untuk Clustering Produktivitas Bawang Merah Menggunakan Metode K-Means," Jurnal Multimedia dan Teknologi Informasi, vol. 07, no. 02, pp. 109–121, 2025, doi: 10.54209/jatilima.v7i02.1442.

[2] K. Pertanian, Angka Tetap Holtikultura Tahun 2023. Direktorat Jenderal Hortikultura, Kementerian Pertanian, 2024.

[3] B. E. L. Tobing, D. I. Simatupang, dan B. Situmorang, "Pemasaran Bawang Merah," Jurnal Methodagro, vol. 7, no. 2, pp. 58–73, 2021.

[4] S. Dwy, T. Hermanto, I. Iswandi, dan D. Darianto, "Analisis Kinerja Mesin Peniris Bawang Untuk Industri Makanan Skala Kecil," IRA Jurnal Teknik Mesin dan Aplikasinya (IRAJTMA), vol. 4, no. 1, pp. 59–68, Apr. 2025, doi: 10.56862/irajtma.v4i1.199.

[5] Mardiana, L. Debataraja, D. A. Siregar, dan N. Hiya, "Pemberdayaan Kelompok Usaha Bawang Goreng melalui Implementasi Mesin Spinner dan Keterampilan Marketing Digital di Kecamatan Medan Johor , Kota Medan," Jurnal Pengabdian kepada Masyarakat dan Desa, no. 2, pp. 29–39, 2022.

[6] I. Baskara et al., "Rancang Bangun Mesin Pengiris Bawang Merah Tipe Vertikal," Agroteknika, vol. 1, no. 1, pp. 39–50, Jun. 2018, doi: 10.32530/agtk.v1i1.21.

[7] R. Aprilliandi, S. Suharyatun, dan A. Haryanto, "Uji Kinerja Mesin Pencacah Tipe Multiguna untuk Pencacahan Tongkol Jagung (Performance Test of Chopper Machine Multifunction Type for Chopped the Corncob)," Jurnal Agricultural Biosystem Engine ering, vol. 1, no. 3, 2022, [Online]. Available: https://jurnal.fp.unila.ac.id/in dex.php/ABE/index

[8] C. Mamonto, E. Sunarti Antu, B. Liputo, and M. dan Peralatan Pertanian, "Optimalisasi Alat Pengiris dan Penggiling Bawang Merah," Jurnal Teknologi Pertanian Gorontalo (JTPG), vol. 9, no. 2, 2024.

[9] D. H. Nurchaya, Y. S. Pramesti, dan A. Akbar, "Rancangan Bangun Alat Pengupas Bawang Merah," Seminar Nasional Inovasi Teknologi UN PGRI Kediri, pp. 194–199, 2021.

[10] M. Nor Ali Aziz, L. Permata Sari Hartanti, M. Nafi, dan R. Wira Pratama, "Perancangan Mesin Terintegrasi Pengupas dan Pemotong Bawang Merah dengan Kapasitas 30 kg/Jam," Journal Widya Teknik, vol. 23, no. 1, 2024.

[11] T. Agus Susanto dan M. Yusuf Yunus, "Rancang Bangun Mesin Pengupas Bawang Merah," Prosiding 4th Seminar Nasional Penelitian & Pengabdian kepada Masyarakat , 2020.

[12] A. Yudhana, I. Bahiuddin, S. Bhirawa Anuraga, A. Winarno, H. Sujatmiko, dan M. R. Ramli, "Desain dan Pengaruh Perangkat Penggerak pada Sistem Pengupas Bawang Putih dengan Sistem Rotasi," 2023.

[13] N. Syamsir, R. Nur, dan A. Salam, "Analyzing and modeling gripper arm using shap e optimization of Fusion 360 and 3D printing of polylactic acid," AIP Conf Proc, vol. 2543, Nov. 2022, doi: 10.1063/12.0010284.

[14] G. Pahl dan W. Beitz, Engineering Design: A Systematic Approach, Second. London: Springer-Verlag London, 1996.

[15] K. T. Ulrich, S. D. Eppinger, and M. C. Yang, Product design and development, 7th ed. McGraw-Hill Education, 2019.

[16] Sularso, Dasar Perencanaan dan Pemilihan Elemen Mesin, 11th ed. Jakarta: PT Pradnya Paramita, 2004.

[17] A. Jamnia, Introduction to Product Design and Development for Engineers. Boca Raton, London, New York: CRC Press, Taylor & Francis Group, 2018.

[18] G. Pandu Annanto dan E. Budi Astuti, "Implementasi Teknologi Mesin Pengupas Bawang Merah Serta Sosialisasi PIRT di UMKM Brambang Goreng Ibu Suwarti di Desa Bringin, Kec. Godong, Kab. Grobogan," Abdimas Unwahas, vol. 7, no. 1, 2022.

[19] F. Maghfurah, R. Effendi, and M. N. Aini, "Perancangan Mesin Pengupas Kulit Ari dan Penghalus Bawang dengan Aplikasi Metode Gesekan Karet," Jurnal Polimesin, vol. 18, no. 1, pp. 39–46, 2020.

[20] T. H. Ghanem, M. M. Badr, K. S. Nagy, and E. A. Darwish, "Evaluation of the Performance Of An Onion Peeling Machine," Pr ocess Engineering Misr J. Ag. Eng, vol. 37, pp. 95–106, 2020.

[21] I. F. Buntoro, R. P. Dewi, and S. Rahmat, "Rancang Bangun Mesin Pengupas Bawang Merah," Politeknik Negeri Cilacap, 2025.