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# Melinjo fruit outer skin peeler prototype design using grate roller based-on auto reverse movement control

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**Abstract**

Cracker snacks made from melinjo fruit are often found in the Pidie Regency area, Aceh. However, processing melinjo seeds into crackers is still manual and takes a long time. In this research, a melinjo peeling machine will be designed to speed up the production process of melinjo crackers. This peeler uses two different electricity sources so it can work in two conditions, namely the PLN(National Electricity Company) electricity supply is on or off. The research method was carried out by collecting data from device testing results and field observations as well as comparing test results with previous research. The movement of the motor is controlled using time delay which gives a command to activate the relay and then turns on the 12 V Direct Current (DC) motor. The motor rotates clockwise and anti-clockwise continuously (auto reverse) according to the direction of positive and negative potential which is controlled by the relay and time delay. The success rate of peeling the outer skin of melinjo seeds using the proposed tool is divided into three types based on differences in seed skin color. The percentage of success for red, orange, and yellowish green melinjo was 68.67%, 51.52% and 25.61% respectively. Thus, in this study, it can be concluded that the most efficient success rate is for red melinjo.

**Keywords:**
Melinjo, time delay, relay, DC motor, auto reverse.

## 1 Introduction

Most of the livelihoods of the people of Paya Village, Pidie District, Aceh Province are mostly making "emping melinjo" known as melinjo chips at home industries scale. The home industry is a business activity that is generally carried out by women. The key process in making chips is the stage of stripping the outer skin of the melinjo fruit. Peeling is done to clean the outer skin of the melinjo fruit. Judging from the low productivity of melinjo fruit, it is due to the cultivation system which is still traditional and completely dependent on nature. In addition, this fruit also depends on the season, therefore the continuity of production can be impeded due to the unavailability of raw materials[1].

The process of removing the outer skin of melinjo seeds in PayaVillage is still done manually. This process poses a risk of irritating the skin of the fingers caused by protease enzymes contained within the seed's skin that can tenderize meat [2], thus it can be damaging to the skin tissue. The manual process of removing the skin affects the amount of production because it takes a longer time. It is said that the manual process is ineffective and inefficient, which has been proved by previous studies [3][4][5][6].

The aims of this research are: 1) increase the effectiveness and time efficiency in removing the outer skin of melinjo, 2) optimize control of auto-reverse motor movement.

The optimization is done by regulating the voltage using a control speed which consists of an IC and a potentiometer that functions as a voltage regulator and voltage divider [7][8], hence the output voltage range can be adjusted according to the needs of the circuit [9]. The motor used is a 12 V Direct Current (DC) motor which is suitable for use in a home industry scale production. The device is also equipped with a backup energy storage system, thus it is capable of working even when the main electrical supply from PLN (National Electricity Company)is down.

The primary energy source is an Alternating Current (AC) from the PLN [10]. While the secondary (emergency) energy source is a battery. The battery used in this study is a Lithium-ion Battery (LIB) type which is generally known to be energy efficient, environmentally friendly, durable, low-cost, and has high power and energy density[11][12][13][14].

The device is activated when the electricity source from PLN is on therefore it can simultaneously charge the battery and will stop charging when the battery condition is full. Then when the PLN is off, an emergency voltage control is used to start the engine with power obtained from the battery thus the device can work continuously which is a solution when there is a power outage to keep the production going.

The power supply used in this study has an important role. The power supply has a series of transformers, rectifiers, filters, and regulatorsto convert high-voltage AC to low-voltage DC [15], making it suitable to use in the home industry production scale. The power supply provides voltage to the Time Delay Relay (TDR) and the battery. When charging the battery there is an auto-cut system that is enabled to terminate charging when it is full and avoid overcharge which can reduce the battery life.

## 2 Research Method

### 2.1 Melinjo (*Gnetumgnemon*)

Melinjo (*Gnetumgnemon*) is a gymnosperm plant native to Indonesia [16], it is cultivated for food purposes and has nutritional and health-promoting effects [17][18]. Fig. 1 shows the shape of the melinjo fruit.


Fig. 1. Melinjo fruit.

Melinjo seeds are often processed into food, medicines, and health supplements along with increasing knowledge about the nutrient content of the melinjo which can protect the human body from free radicals[19]. The shape of the melinjo seeds is shown in Fig 2.

Fig. 2. Melinjo seeds.

Melinjo can be differentiated into 3 colors (i.e. greenish yellow, orange and red). These colors can be used to distinguish the level of maturity of the melinjo[20]. A mixture of various melinjo fruit outer skin colors is shown in Fig. 3. The difference in the melinjo fruit colors indicates the hardness of the skin and the maturity of the fruit. The more mature or older the melinjo fruit, the softer the texture of the outer skin and the easier it is to peel. The outer skin of melinjo has a different thickness according to the water content contained therein where the thickness range is 0.5-1 mm. The chemical compounds that are beneficial for health contained in melinjo skin include saponins, tannins, flavonoids, and triterpenoids which have antibacterial properties [21].

Fig. 3. Various colors of melinjo outer skin.

### 2.2 Grated Roller Blade

The mechanism for removing the outer skin of the melinjo fruit in this study is by using a grate roller blade which is shown in Fig. 4.

Fig. 4. Grate roller-type blade.

The grate roller is shaped in the form of a horizontal tube with a diameter of 62 mm and a length of 200 mm. It has a total number of 16×8 small blades attached to the roller, thus the result of the peeling process is thin like shaving or grating. The roller body is made of a 2.5 inch pipe with a length of 200 mm and a 3inch pipe as a cover.

### 2.3 Auto Reverse Movement System

The auto reverse movement system is an automatic Clockwise (CW) and Counterclockwise (CCW) motor motion caused by the change of DC motor polarity. The polarity change is controlled by the time delay relay. The control is set in the form of time delays which can be input manually, therefore the movements can happen automatically. The time delay for auto-reverse control is set for 5 seconds each, clockwise and counterclockwise. This system has been implemented using a DC motor in previous studies in the form of a semi-automatic peeling device [22]. DC motor is an electromagnetic device that can convert electrical into mechanical energy [6][23][24], thus it can rotate the blade to peel the outer skin of the melinjo.

### 2.4 Methodology and Implementation

The process that has been done during this research started with collecting melinjo, separating the melinjo into three categories based on color, peeling melinjo, and the peeling process using the prototype device. The results of the peels result can be divided into three types, which are clean, partially clean, and damaged seed. The research methodology is shown in Fig. 5.

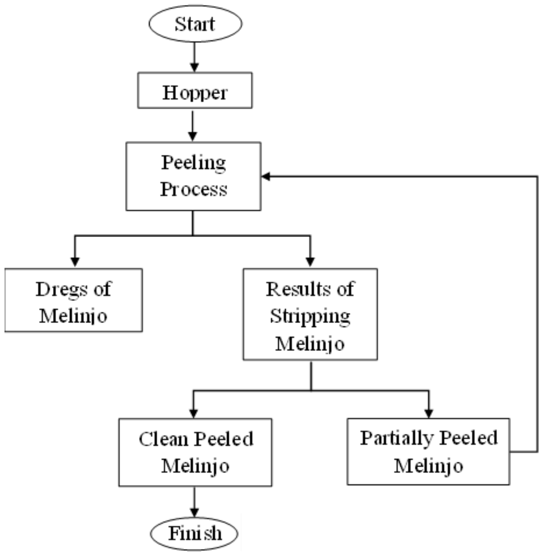


Fig. 5. Research methods.

#### 2.4.1 Prototype Design

The prototype that has been designed has the following dimensions, length 480 mm, width 500 mm, and height 980 mm as shown in Fig. 6.

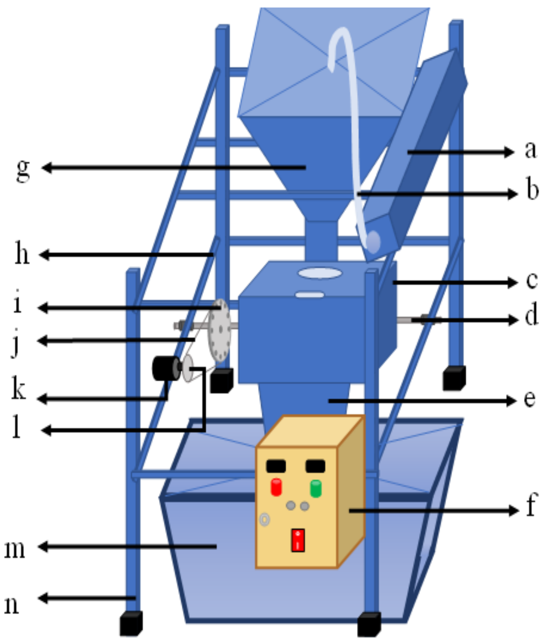


Fig. 6. The device prototype.

Fig. 6 caption:

a. Water box
b. Water hose
c. Melinjo box
d. Nut, bolts, and bearing
e. Skin duct
f. Box panel
g. Hopper
h. Iron frame
i. Pulley
j. V-belt
k. Motor DC
l. Motor pulley
m. Skin container
n. Iron pole

The prototype material is composed of a frame made of iron, a hopper made of acrylic, and a holding basin made of wood coated with acrylic. The roller is made from an iron plate with 16×8 small blades attached around it.

### 2.4.2 Schematic Design

It can be seen from Fig. 7 that the schematic device has a battery for an emergency voltage storage system to make sure that the device is working even when the main electricity source (PLN) is malfunctioning.

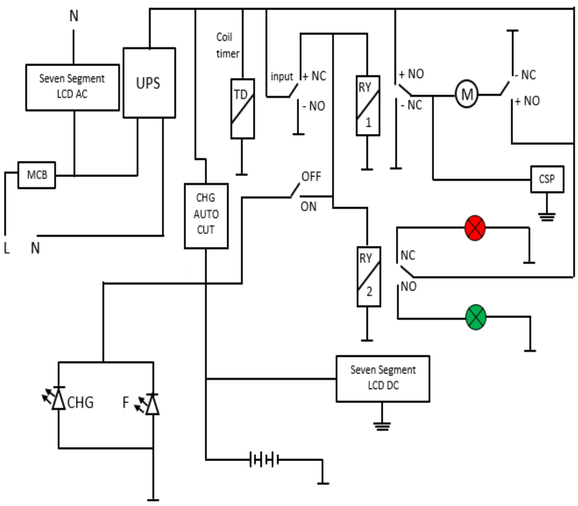


Fig. 7. System schematic for the device prototype.

The operation of the device starts from a PLN 220 V 50 Hz AC source that is connected to the power supply. The power supply converts the AC source into 12 V DC voltage and supplies the power to the time delay. When the time delay receives the voltage it will be displayed on the LCD AC to inform the operator that the device is ON. Time delay is also used to control the motor movement by setting the time for the polarity change to occur (in this study, it is set at 5 seconds), thus the moving direction of the motor will change from CW to CCW and vice versa every 5 seconds (auto reverse). The switch to change the polarity direction is controlled by Relay 1 (RY1). RY1 works forward when it receives power from the time delay, while the time delay position is at Normally Open (NO). When the time delay reaches the specified time limit (5 seconds), RY1 works in reverse and the time delay position is in Normally Close (NC). Relay 2 (RY2) controls the indicator lamp to show the operator the movement direction of the motor with a red lamp indicating forward movement (CW) and a green lamp indicating reverse movement (CCW).

The emergency power source from the battery produces a DC voltage of 12 V 16 Ah, which is used when the PLN network is down. The DC voltage value is displayed on the LCD DC to inform the operator that the emergency power is ON and to detect the DC voltage supplied to the motor. The emergency battery will be charged when the PLN network is back to normal and there is an additional auto-cut circuit system that is implemented to cut off charging when the battery is full. The charging is indicated by the LED light that lights up and off when the charging is done. Furthermore, there is a Main Circuit Breaker (MCB) which functions as a means of protection in the event of a short circuit,and a speed control that is used to adjust the speed of the motor according to the capacity of the melinjo seeds that is fed into the hopper.

### 2.4.3 Data Analysis

In the process removing of the outer skin, melinjoseedsare categorized by skincolor (i.e., red, orange and yellowish green). In this study the focus was on red melinjo which has the softest skin texture, thus making it easier to do the peeling process. The red melinjo that is selected has a sample of 130 seeds. The results are split into three divisions, namely clean, partially clean, and damaged seed.

### 2.4.4 Testing Based on Differences in Skin Color

Three different kinds of seeds based on skin color difference are tested which had different percentages of peeling success results. The percentage calculation for each color was calculated using Eq. 1, Eq. 2 and Eq. 3 [25].

$$\%C = \frac{CS}{PS} x100\% \quad (1)$$

$$\%A = \frac{AS}{PS} x100\% \quad (2)$$

$$\%D = \frac{DS}{PS} x100\% \quad (3)$$

Based on Eq. 1 it is explained that the percentage of seed that is clean from skin (%C) is obtained from the result of dividing the number of Clean Seeds (CS) by the number of all the Process Seeds (PS) and multiplied the result by 100%. From Eq. 2 it is explained that the percentage of partially clean results with some skin still attached to the seed (%A) is obtained by dividing the number of partially attached skin on the seed (AS) by the number of all the Process Seeds (PS) and multiplied the result by 100%. Furthermore, from Eq. 3 it is explained that the percentage of the seed that is damaged during the process (%D) is obtained by dividing the number of Damaged Seeds (DS) by the number of all the Process Seed (PS) and multiplied the result by 100%.

## 3 Results and Discussion

The design results for the device can be seen in Fig. 8.

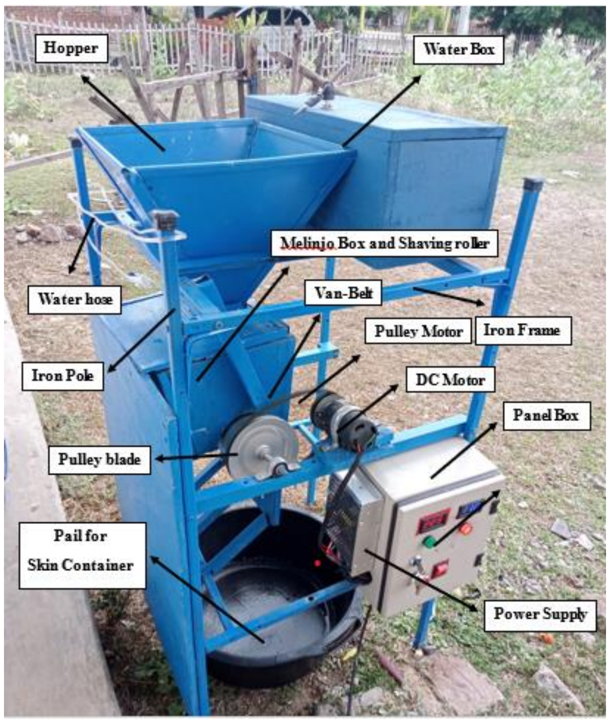


Fig. 8. The realization of the melinjo fruit outer skin peeler prototype design using a grate roller based onauto-reverse movement control built upon Fig. 6.

### 3.1 Results on Red Color Melinjo Seed

The result of the prototype trial on red color seed with 130 seed samples is differentiated into clean, partially clean, and damaged seeds. The outcome can be seen in Table 1.

Table 1. Results on red color melinjo seed

| Number of red seed trials | Number of clean seed | Number of partially clean seed | Number of damaged seed | Process time (second) |
|---|---|---|---|---|
| 1 | 73 | 51 | 6 | 161 |
| 2 | 91 | 38 | 1 | 187 |
| 3 | 104 | 13 | 13 | 99 |
| Mean | 89 | 34 | 7 | 149 |

Table 1 shows the trial results on red melinjo seeds. The longest processing time measured using a stopwatch was 187 seconds or 3.07 minutes in the 2nd trial. While the fastest processing time was 99 seconds or 1.39 minutes in the 3rd trial. The average time from Table 1 was 149 seconds or 2.29 minutes.

### 3.2 Results on Orange Color Melinjo Seed

The result of the prototype trial on orange color seeds with 130 seed samples is differentiated into clean, partially clean, and damaged seeds. The outcome can be seen in Table 2.

Table 2. Results on orange color melinjo seed

| Number of orange seed trials | Number of clean seed | Number of partially clean seed | Number of damaged seed | Process time (second) |
|---|---|---|---|---|
| 1 | 71 | 52 | 19 | 157 |
| 2 | 75 | 55 | 13 | 233 |
| 3 | 75 | 58 | 10 | 202 |
| Mean | 73 | 55 | 14 | 197 |

Table 2 shows the trial results of the orange melinjo seeds. The longest processing time was the 2nd trial with 233 seconds or 3.53 minutes. The fastest processing time was the 1st trial with 157 seconds or 2.37 minutes. The average time to process the orange seeds can be seen in Table 2 with 197 seconds or 3.17 minutes.

### 3.3 Results on Yellowish Green Color Melinjo Seed

The result of the prototype trial on yellowish-green color seeds with 130 seed samples is differentiated into clean, partially clean, and damaged seeds. The outcome can be seen in Table 3.

Table 3. Results on yellowish-green color melinjo seed

| Number of yellowish green seed trials | Number of clean seed | Number of partially clean seed | Number of damaged seed | Process time (second) |
|---|---|---|---|---|
| 1 | 52 | 78 | 26 | 606 |
| 2 | 71 | 97 | 13 | 627 |
| 3 | 13 | 182 | - | 650 |
| Mean | 45 | 119 | 13 | 628 |

Table 3 shows the trial results of yellowish-green melinjo seeds. The longest processing time was the 2nd trial with 650 seconds or 10.50 minutes. The fastest processing time was the 3rd trial with 606 seconds or 10.06 minutes. The average time to process the yellowish-green seeds was 628 seconds or 10.28 minutes as shown in Table 3.

The trial results of the red, orange, and yellowish-green melinjo seeds can be seen in graphical format in Fig. 9.Fig. 9 shows a graph of the number of trials against the processing time on three different color seeds. The processing time ranges from 99-650 seconds or 1-11 minutes depending on the hardness of the skin which is shown by the color of the melinjo seed. The yellowish green is the hardest while red is the softest. Red seeds take 99-187 seconds or 1-3 minutes, orange seeds take 157-233 seconds 2-4 minutes, and yellowish green seeds take 606-650 seconds or 10-11 minutes to be processed. It can be concluded that the most efficient process time is the red melinjo seeds.

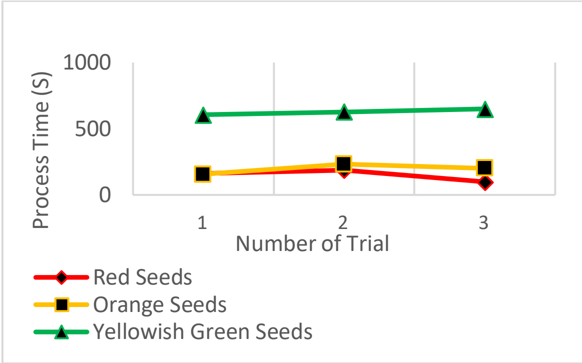


Fig. 9. Trial results of melinjo seeds peeling process.

### 3.4 Percentage of Success on Red Melinjo Seeds

The success percentage of the red melinjo seeds peeling process is divided into three groups namely clean, partially clean, and damaged seeds. Thepercentage results can be seen in Table 4.

Table 4. The percentage results of the red seed process

| Number of trials | Percentage of clean seeds(%) | Percentage of partially clean seeds(%) | Percentage of damaged seeds(%) |
|---|---|---|---|
| 1 | 56 | 39 | 5 |
| 2 | 70 | 29 | 1 |
| 3 | 80 | 10 | 10 |
| Mean | 69 | 26 | 5 |

The percentage of melinjo seeds that have been peeled cleanly is calculated according to Eq. 1, the percentage of melinjo seeds that have been peeled partially clean is calculated according to Eq. 2, and the percentage of melinjo seeds that have been damaged in the peeling process is calculated according to Eq. 3. Based on the data in Table 4, the average result percentages were 69%, 26%, and 5% respectively.

## 4 Conclusion

Based on the research results, the device prototype can work in two conditions, namely when the electricity from the main power source (PLN) is ON or OFF. The movement of the grate roller can change direction forward (CW) and reverse (CCW) automatically according to the time specified in the time delay, in this research the time is set at 5 seconds. The level of efficiency was measured from the test results where within 5 seconds the number of melinjos that could be peeled reached 89 grains and the percentage of clean seeds without skin was 69% red, 51% orange melinjos, and 25% yellowish green.

## References


[1] K. Saleh, ‘The Role of Emping Melinjo Home Industry in Increasing Family Income in Warung Gunung District , Lebak Regency’, *Int. J. Adv. Res. Econ. Financ.*, vol. 5, no. 1, pp. 353–361, 2023.

[2] F. Abdurrahman and O. Omar, ‘Analysis of protease activity of melinjo (Gnetum gnemon L.) skin on the tenderness of buffalo meat’, *J. Nat.*, vol. 23, no. 2, pp. 92–97, 2023, doi: 10.24815/jn.v23i2.28624.

[3] A. L. Jerald, E. Bhavashri, G. Rubika, and A. S. Devi, ‘Design and Development Of Fruits Or Vegetables Peeler Cumslicer and Dryer’, *J. Sci. Technol.*, vol. 7, no. 03, pp. 22–29, 2022.

[4] G. Li *et al.*, ‘WFDC12-overexpressing contributes to the development of atopic dermatitis via accelerating ALOX12/15 metabolism and PAF accumulation’, *J. Cell death Dis.*, vol. 14, no. 3, p. 185, 2023, doi: 10.1038/s41419-023-05686-3.

[5] F. Zuhra and T. I. Fajri, ‘Application of Appropriate Technology for Cracker Printing Machines for Mulieng Cracker Production on Mulieng Cracker Craftsmen in Padang Village , Simpang Tiga District as A Leading Product of Pidie Regency’, *Proc. Int. Conf. Sustain. Innov. 2022 Appl.*, no. July, pp. 20–21, 2022.
[6] S. Situmorang, ‘Application of Roboduino ATMega 2560 in the Making of the Fire Extinguisher Beetle Robot’, *J. Sci. Technol.*, vol. 2, no. 1, pp. 54–59, 2020, doi: 10.55299/jostec.v2i1.53.
[7] M. A. Alzubaidi, M. Otoom, and A. M. Abu Rwaq, ‘A Novel Assistive Glove to Convert Arabic Sign Language into Speech’, *ACM Trans. Asian Low-Resource Lang. Inf. Process.*, vol. 22, no. 2, pp. 1–16, 2023, doi: 10.1145/3545113.
[8] P. Khedekar, S. Kamthe, T. Jaiswal, and P. P. Shinde, ‘Smart Car Parking System’, *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 9, no. 09, pp. 631–635, 2021, doi: 10.48175/ijarsct-1451.
[9] M. Naeem, M. Abuzer, S. T. Sahi, and T. Imran, ‘Microcontroller-Based Thermoelectrically Stabilized Laser Diode System’, *Arch. Adv. Eng. Sci.*, vol. XX, no. April, pp. 1–8, 2023, doi: 10.47852/bonviewAAES32021023.
[10] Suwitno, Slamet, A. Hamzah, I. H. Rosma, F. Murdiya, and D. Y. Sukma, ‘Design and development of Single Phase Inverter with Regulated Output Voltage’, *Proceedings of the International Conference on Electrical Engineering and Informatics*, vol. 2022-Octob. pp. 114–119, 2022, doi: 10.1109/IConEEI55709.2022.9972316.
[11] C. Lin, W. Kong, Y. Tian, W. Wang, and M. Zhao, ‘Heating Lithium-Ion Batteries at Low Temperatures for Onboard Applications: Recent Progress, Challenges and Prospects’, *Automot. Innov.*, vol. 5, no. 1, pp. 3–17, 2022, doi: 10.1007/s42154-021-00166-w.
[12] X. Zhang, Z. Li, L. Luo, Y. Fan, and Z. Du, ‘A review on thermal management of lithium-ion batteries for electric vehicles’, *Energy*, vol. 238, part A, 2022, doi: 10.1016/j.energy.2021.121652
[13] J. Tian, R. Xiong, W. Shen, J. Lu, and X. G. Yang, ‘Deep neural network battery charging curve prediction using 30 points collected in 10 min’, *Joule*, vol. 5, no. 6, pp. 1521–1534, 2021, doi: 10.1016/j.joule.2021.05.012.
[14] J. Xie and Y. C. Lu, ‘A retrospective on lithium-ion batteries’, *J. Nat. Commun.*, vol. 11, no. 1, pp. 9–12, 2020, doi: 10.1038/s41467-020-16259-9.
[15] K. M. Reddy, P. S. Babu, L. Meghana, S. V. Akram, and K. V. Suresh, ‘Pick And Place Bluetooth Control Robotic Arm’, *J. Eng. Sci.*, vol. 14, no. 04, pp. 1351–1355, 2023.
[16] A. J. N. Parhusip, N. S. Adara, and A. N. Widyapranata, ‘Characteristics of Red Melinjo Peel Powder Encapsulate with Spray Drying Method’, *GCISTEM Proceeding*, vol. 1, pp. 31–40, 2022, doi: 10.56573/gcistem.v1i.17.
[17] A. Berbudi, ‘Effect of Resveratrol in Melinjo Seed (Gnetum gnemon L.) Extract on Type 2 Diabetes Mellitus Patients and its Possible Mechanism: A Review’, *J. Betham Sci.*, 2023, doi: 10.2174/1573399818666220228160908.
[18] A. Sukohar, Suharyani, Sutyarso, H. Busman, N. Nurcahyani, and E. Kurniawaty, ‘Antioxidant and Cytotoxic Activities of Melinjo (Gnetum gnemon L.) Seed Fractions on HeLa Cell Line an In Vitro’, *Pharmacogn. J.*, vol. 14, no. 3, pp. 559–564, 2022, doi: 10.5530/pj.2022.14.71.
[19] M. Sari, S. I. Rahmawati, F. N. Izzati, Bustanussalam, and M. Y. Putra, ‘Antioxidant Activity of Ethanolic Extract of Peel and Seed Melinjo (Gnetum gnemon) Based on Color Variations’, *Proc. 1st Int. Conf. Heal. Res. – BRIN (ICHR 2022)*, pp. 255–265, 2023, doi: 10.2991/978-94-6463-112-8_25.
[20] D. Iskandar, and M. Marjuki, ‘Classification of Melinjo Fruit Levels Using Skin ColorDetection With RGB and HSV’, *J. Appl. Eng. Technol. Sci. Vol*, vol. 4, no. 1, pp. 123–130, 2022.
[21] J. Honga, A. J. N. Parhusip, N. A. Anugrahati, W. S. L. Sinaga, and V. Angel, ‘Stabilization of red melinjo peel (gnetum gnemon L.) ethyl acetate extract as antibacterial agent’, *J. Funct. Food Nutraceutical*, vol. 1, no. 1, pp. 1–12, 2019, doi: 10.33555/jffn.v1i1.7.
[22] C. H. Li, Y. T. Hsu, C. H. Hsieh, and C. W. Cheng, ‘A novel semiautomatic flesh peeling and seed removing mechanism for dried longan’, *Agric.*, vol. 11, no. 1, pp. 1–11, 2021, doi: 10.3390/agriculture11010048.
[23] R. Dev *et al.*, ‘Design , Construction , and Performance Evaluation of the Chaff Cutter Machine in Nepal Design , Construction , and Performance Evaluation of the Chaff Cutter Machine in Nepal’, *Int. Res. J. Eng. Technol.*, no. 10, iss. 3, pp. 126-131, March 2023.
[24] E. Cetin, ‘Brushless Direct Current Motor Design and Analysis’, *COJ Electron. Commun.*, vol. 2, no. 2, 2021, doi: 10.31031/cojec.2020.02.000534.
[25] E. Sulistiyowati, S. Setiadi, and E. Haryono, ‘The Dynamics of Sustainable Livelihoods and Agroforestry in Gunungkidul Karst Area, Yogyakarta, Indonesia’, *For. Soc.*, vol. 7, no. 2, pp. 222–246, 2023, doi: 10.24259/fs.v7i2.21886.