

Development of an Improved Groundnut Roasting and Peeling Machine

Abstract

Aim: This research aims to develop an improved groundnut roasting and peeling machine that reduces human effort and increases productivity.

Study Design: Redesign the existing groundnut roasting machine by incorporating a peeling chamber, fabricate an improved groundnut roasting machine, and evaluate the performance of the groundnut roasting and peeling machine.

Place and Duration of Study: Department of Mechanical Engineering, The Federal University of Technology, Akure, Ondo State, Nigeria, between February 2021 to November 2025.

Methodology: The method used consists of designed components utilizing SolidWorks software, which includes a roasting chamber, a peeling chamber, and the necessary specifications for roasting groundnuts, peeling groundnuts, and their required power and speed, which are essential for the completion of this study.

Results: This study found that the time required to peel 5 kg of groundnuts by hand is approximately 3-5 hours, while the time taken to peel the same quantity using the machine is 14 minutes, with a peeling efficiency of 90%. It was also observed that the mass before roasting is relatively different, and a machine operated at varying revolutions per minute yields different values after peeling.

Conclusion: A groundnut roasting and peeling machine was constructed using readily available materials and is suitable for local production of roasted and peeled groundnut seeds. The machine is simple to operate, repair, and maintain. The technology is affordable and less costly compared to imported roasting and peeling machines. It has low operational costs; it is compact, of moderate weight, produces minimal noise, and operates without vibrations. Therefore, it can be concluded that the weight of groundnuts before roasting varies, and the machine operated at different revolutions per minute yields different peeling results. The time required to peel 5 kg of groundnuts manually is approximately 3-5 hours, whereas the same amount can be peeled using this machine in just 14 minutes. The machine achieves a peeling efficiency of 90% and a capacity of 19.6 kg/hour of peeled groundnuts. This clearly shows that peeling roasted groundnut seeds with this machine is more advantageous than doing so manually, and it represents an improvement over previously fabricated designs.

Keywords: Development, Performance Evaluation, Groundnut Roasting and Peeling Machine

1. INTRODUCTION

Advancements in technology are often referred to as an increase in the efficiency with which humans exploit their physical environment to meet their needs. With such technological advancements, productivity can grow rapidly compared to the population. The discovery of petroleum in the country led to the abandonment of many agricultural products, including groundnuts. This act actually affects the economy because a larger population of the country earns their living through farming. Groundnut has the highest oil content of all food crops and is second only to soybean in terms of protein content (20-30%) among the food legumes [1]. As a legume, it plays a huge role in feeding humans and animals, particularly in third-world countries, where they meet as much as two-thirds of human nutritional needs. Moreover, because they can pull nitrogen out of the air, they do not need much chemical fertiliser. Thus, it makes it a better bargain for poor farmers who cannot afford fertilisers and a boon to richer ones [2].

A large number of food products are prepared from groundnuts, including boiled nuts, roasted nuts, salted nuts, groundnut milk, groundnut yoghurt, groundnut bars, groundnut butter, groundnut cheese, and bakery products, among others [3]. In Nigeria, groundnuts are processed into finished products for human consumption, and this requires diverse methods of local preparation, as practised in some localities or ethnic groups. Some of these uses and their preparations are not documented in writing but are instead passed down from generation to generation through oral means of communication; therefore, these uses and preparations may fade away as those who know them pass away. Groundnut is one of the most popular commercial crops in Nigeria. Nigeria accounted for about 54% of West African groundnut production [4]. In Nigeria, the processing of groundnuts into various products is primarily done by women, either for home consumption or for commercial purposes [5]. The most common commercial products of groundnuts are groundnut oil, groundnut cake, and fried groundnuts, which are sold at marketplaces or hawked on the streets [6].

This research aims to develop an improved groundnut roasting and peeling machine that reduces human effort and increases productivity.

The research scope focused on developing an improved method for roasting and peeling groundnut seeds, and a redesigned machine was fabricated based on the existing one, evaluated, and tested. The machine has two chambers: a roasting chamber and a peeling chamber. It is also a continuous flow such that the two chambers of the machine operate simultaneously.

2. LITERATURE REVIEW

Raw groundnuts are consumed all over the world. [7] reported that roasted groundnuts are processed by heating them to 180 °C for approximately 12–15 min or to 160 °C for 40–60 min, depending on the moisture content. Effect of addition of groundnut skin into groundnut butter on antioxidant and total phenolic content, and observed a significant increase in the fibre, phenolics and antioxidant content of butter prepared.

[8] developed a manually operated groundnut roaster. The performance evaluation test conducted revealed that the machine takes 1.03, 1.63, and 2.35 minutes to roast 1.5, 2, and 3 kg of shelled groundnuts, respectively.

According to [9], Roasting enhances extraction by reducing the oil's viscosity, releasing oil from intact cells, and reducing moisture content. The amount of oil produced will be significantly more if the oil is roasted correctly. However, excess heating during roasting results in a lower nutritional quality of the protein. It also reduces the amount of oil and makes the extracted oil darker.

[10] modified the existing roaster. The machine, when tested with a 6.6 kg sample of groundnut seeds, achieved output capacities of 32.5 kg/hr, 95.5% roasting efficiency, and 5.1 kg/hr for fuel consumption.

[11] developed a manually operated de-sinning and winnowing machine. The central unit of the machine is the polishing chamber, which comprises the rough surface plate and the scrubber. The groundnut seed passes through a distance called polishing clearance, which is between the rough surface plate and the scrubber. The machine required 0.34 kW of power, had a throughput capacity of 27.47 kg/hr, and an efficiency of 53%.

[12] developed a groundnut peeling machine to generate a capacity of up to 25 kg/hour using an electric drive motor with efficient electrical power at ¼ HP (185 W) with a rotary system of multi-discs able to reduce any damage to groundnut husk peeling to below 5% (more than 95% of the intact peeling).

[13] developed a manually operated groundnut roaster with a roasting capacity of 0.92 kg/min, achieving a roasting efficiency of 98.9%. [14] modified to improve efficiency in groundnut roasting, enhance appearance, and reduce drudgery during operation by adopting a new heat source (charcoal) and using anthropometric data from the

sampled population to determine the machine's dimensions. The machine was tested using a 6.6 kg sample of groundnut, the same as used for the existing machine. The parameters evaluated indicate that the modified device has a roasting efficiency of 98%, a fuel consumption rate of 3.84 kg/hr, and an output capacity of 15 kg/hr.

[15] evaluated a locally fabricated roasted groundnut dehuller, and the test results showed that the dehuller's operating speed and the roasted groundnut moisture content significantly affect mechanical damage and dehulling efficiency. The dehuller's efficiency decreased as speed increased. It achieved the highest efficiency of 92.1% at 9% moisture content and an operating speed of 30 rpm, while mechanical damage was minimal (1.86%) in the runner groundnut variety. All materials used for fabrication were sourced locally. The dehuller has a capacity of 5.3 kg/h of roasted groundnut seeds.

Based on literature searches conducted so far, different types of roasting and peeling machines have been developed to address challenges encountered in manual processing. However, issues such as time wastage, labour costs, inadequate collection, groundnut peels falling freely from a height causing splitting into multiple pieces, and the need for manual intervention by the operator still persist. Therefore, it is crucial to improve the groundnut roasting machine so that it can roast and peel groundnuts without burning or damaging the shells, while requiring minimal human input.

3. METHODOLOGY

This study involves developing an improved groundnut roasting and peeling process, which includes components such as heater capacity, power requirements, feed hopper, shaft, stirrers, roasting cylinder, tilting handle, and electrical parts like heating elements, temperature regulator, step-down transformer (standard), DC electric motor, variable speed electric motor, universal joint coupling, and others. Standard values were used to determine the design and specifications. Fasteners and arc welding were employed for their strength, durability, ease of operation, and cost-effectiveness.

3.1 Materials

The materials selected for fabrication were chosen after a thorough examination of their physical, mechanical, chemical, and aesthetic properties, as shown in Table 1 for this study. Due to economic considerations and material availability, high- and medium-carbon steel were mainly used, while stainless steel was employed for the body parts.

Table 1: Selections of Materials

MACHINE COMPONENTS	CRITERIA FOR SELECTION	MOST SUITABLE MATERIAL	MATERIAL ACTUALLY SELECTED	REASON FOR SELECTION	LIMITATION OF SELECTED MATERIAL
Hopper	Smooth	stainless steel	stainless steel	Does not react with feeds. Light, easily fabricated, weldable, and resistant to corrosion.	It is expensive
Frame	1. Tensile strength 2. Malleability	Mild steel	Mild steel	It has good resistance to shock and wear	It is not expensive
Handle	Tensile strength	Mild steel	Mild steel	Tensile strength	It is not expensive

Roasting and peeling chamber	Smooth	Stainless steel	stainless steel	and does not react with groundnut	It is expensive
Shaft	Smooth and ductile	stainless steel	Stainless steel	It has high resistance to wear and resistance to distortion, and does not react with groundnut.	It is expensive.
Bearing	To support the shaft	Cast Iron	Cast Iron	It runs smoothly	It is expensive
Electric Motor	To run the machine	Cast iron in winding steel	Cast iron in winding steel		
Bolts and Nuts	Link fastener	Mild steel	Mild steel	Does not react with groundnut	It is not expensive

3.2 Design and Fabrication of Groundnut Roasting and Peeling Machine

The machine for roasting and peeling groundnuts consists of two chambers: the roasting chamber and the peeling chamber.

3.2.1 Design of Roasting Chamber

The design analysis was carried out to identify the parameters needed to select the suitable grade and size of materials for manufacturing various machine components. According to the specification, the total amount of groundnuts to be roasted at once is 5 kg.

From the mechanical properties of groundnut, the density of groundnut is 752.34 kg/m^3

Recall that

$$\rho = \frac{M_g}{V} \quad 3.1$$

where,

M_g is the mass of a groundnut

V is volume

ρ is density

Therefore, the volume occupied by the specified mass of groundnut is given by $V = \frac{M_g}{\rho} = \frac{5}{752.4} = 0.00664 \text{ m}^3$

The roasting chamber was designed to be cylindrical, ensuring uniform heat distribution across its walls.

The dimensions of the cylinder required to contain the desired mass of the groundnut are given as follows:

$$V = \pi \frac{D^2}{4} H \quad 3.2$$

where,

D^2 is the diameter of the roasting chamber

H is the height of the cylinder

V is the volume of the roasting cylinder

For the analysis of the roasting chamber, the minimum ratio of the H/D = 1

Therefore,

$$V = \pi \frac{D^3}{4} \quad , \quad D = \sqrt[3]{\frac{4V}{\pi}}$$

$$D = \sqrt[3]{\frac{4 \times 0.00664}{\pi}} = 0.204m = 204mm$$

This is the minimum diameter to contain the groundnut. But create enough room for turning of groundnut and accommodate variation in sizes of the groundnut, the dimensions of the inner cylinder selected are D = 0.24 m and L = 0.2m

3.2.3 Heat required for Roasting Groundnut

From the thermal properties of groundnut, it is known that the specific heat capacity of groundnut is 1.314 kJ/kgK [16].

The total energy required to roast the groundnut is given by

$$E = M_g C_g \Delta T \tag{3.3}$$

where M_g is the Mass of a groundnut

C_g is the Specific Heat Capacity of groundnut

ΔT is a change in Temperature

According to the research on the thermal processes and properties of groundnuts by [17], the most advantageous processing temperature for groundnuts is 140 °c. This is because nuts roasted above 140°C showed excessive redness.

Therefore, the energy adequate for roasting is:

$$E = M_g C_g \Delta T = 5 \times 1.314 \times (140 - 27) = 732.41 \text{ kJ}$$

Considering the diameter of the cylinder for the selected roasting, the chosen heating band is 1.4 kw, with a diameter of 240 mm and a height of 120 mm.

Heat flux of the heating band

$$Q_1 = \frac{W}{\pi DL - 0.0254L} \tag{3.4}$$

$$= \frac{1400}{\pi \times 0.24 \times 0.12 - 0.0254 \times 0.12} = 16012.83 \text{ W/m}^2.$$

Heat flux lost

$$Q_2 = \frac{T_i - T_o}{\frac{x_1}{k_1} + \frac{x_2}{k_2} + \frac{x_3}{k_3}}$$

$$= \frac{140 - 27}{\frac{2 \times 0.003}{54} + \frac{0.050}{0.18}} = 406.64 \text{ W/m}^2$$

Heat flux available

$$Q = Q_1 - Q_2$$

$$= 16012.83 - 406.64 = 406.64 \text{ W/m}^2.$$

Power required for roasting

$$P = Q \times A \tag{3.5}$$

$$= 15606.67 \times 0.151 = 2353.43 \text{ Watts}$$

Surface area of a cylinder

$$A = \pi DL \tag{3.6}$$

where,

D is the diameter of the Cylinder

L is the length of the Cylinder

π is 3.142

$$= \pi \times 0.2 \times 0.24 = 0.151 \text{ m}^2$$

Time required for roasting

$\frac{\text{Energy adequate for roasting}}{\text{Power required for roasting}}$

$\frac{732.41 \times 10^3}{2353.43} = 311.2 \text{ sec} = 5 \text{ min}$

3.3 Design of Peeling Chamber

3.3.1 Force required to Peel Groundnut

To determine the force needed to peel the groundnut, we must select the force capable of rupturing the groundnut kernel. Any force below this critical value is sufficient to peel the groundnut.

According to the research conducted by [18] on the mechanical behaviour of groundnut kernels under compressive load, it was deduced that the minimum force required to rupture the groundnut kernel is 60 N.

3.3.2 Design of the Peeling Chamber

Due to the available material, the peeling brush available has the following:

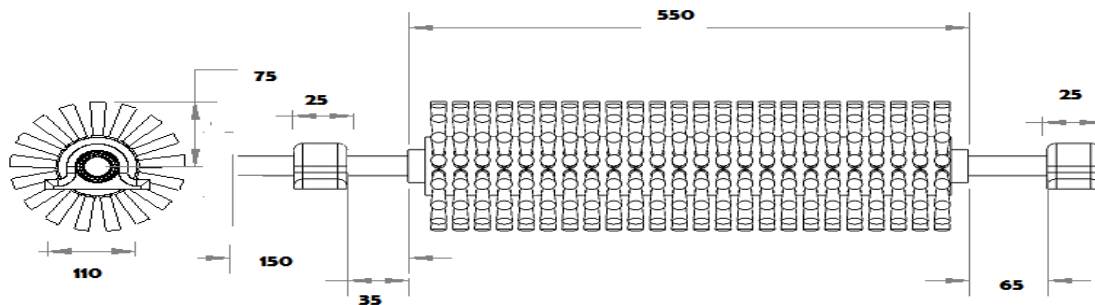


Fig. 1: Shows the Peeling Brush

From the geometry of the peeling brush above, we can identify the minimum size needed to cover the entire groundnut being roasted. We remember that the volume of 5 kg of groundnut is 0.00664 m³.

Total volume that can be occupied by groundnut kernel is:

$$V = \text{volume of peeling chamber} - \text{volume of peeling brush}$$

For the length of the peeling chamber, a measurement of 600 mm was chosen to accommodate the entire length of the peeling brush and allow clearance for its free rotation. To determine the minimum diameter, we recall that:

$$V = \frac{\pi}{4} (D^2 L - d^2 l) \tag{3.7}$$

$$\text{therefore } D = \sqrt[2]{\frac{1}{L}\left(\frac{4V}{\pi} + d^2l\right)}$$

$$D = \sqrt[2]{\frac{1}{0.6}\left(\frac{4 \times 0.00664}{\pi} + 0.11^2 \times 0.55\right)}$$

$$D = 0.158 \text{ m} = 158 \text{ mm}$$

To accommodate the spaces occupied by the shaft and the brushes, a diameter of 170mm was used, as shown below.

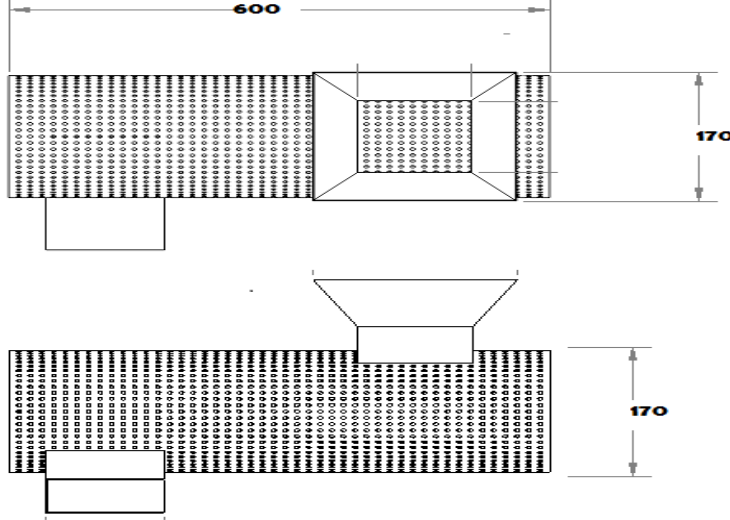


Fig. 2: Shows the Peeling Chamber

3.3.3 Speed Required to Peel Groundnut

Remember that the force needed to peel a groundnut must be less than the minimum rupture force of 60 N. To do this, we recall that the centrifugal force caused by the rotation of the brush is given by:

$$F = \frac{M_g \omega^2 d}{2} \quad 3.8$$

Where,

M_g is the mass of a groundnut

ω^2 is the speed of the peeling shaft

d is the diameter of the peeling brush

Therefore,

$$\begin{aligned} \omega &= \sqrt{\left(\frac{2F}{M_g d}\right)} \\ &= \sqrt{\left(\frac{2 \times 60}{5 \times 0.11}\right)} = 14.77 \text{ rad/s} \end{aligned} \quad 3.9$$

$$\begin{aligned} \text{Speed is } N &= \frac{60\omega}{2\pi} \\ &= \frac{60 \times 14.77}{2\pi} = 140 \text{ rpm} \end{aligned}$$

3.3.4 Time Required Peeling the Groundnut

The time required to peel 4.50 kg of roasted groundnut seed was 14 minutes (0.23 hours), i.e., until the red skin of the groundnut ceased to come off. The capacity of the machine is therefore;

$$\text{Capacity} = \frac{\text{Weight}}{\text{Time}} = \frac{4.50}{0.23} = 19.6 \text{ kg/hr}$$

3.3 Mode of Operation

Power is supplied to the machine from an external source. When the D.C. electric motor receives electrical power, it rotates, producing rotational motion in the shaft, which is transmitted to the stirrer to ensure the groundnuts are stirred continuously and evenly. The heating elements are also powered electrically to generate the heat needed for roasting. A heat regulator controls the amount of heat produced. Once the machine reaches its maximum temperature, the groundnuts are fed into the roasting chamber and roasted. The roasted groundnuts are then poured into the hopper of the peeling chamber and allowed to cool. Afterwards, the groundnuts are peeled, with the peeling process also blowing out the red skin with a blower simultaneously. The groundnuts are then bottled and are ready for sale or consumption.

3.4 Servicing Safety

Personnel in contact with oil and solvent may develop skin dermatitis. To minimise the risk of infection, apply barrier creams to the hands and wear appropriate gloves. When using solvents, ensure the areas are well ventilated, preferably with a forced draught. Additionally, it is advisable that all personnel wear eye shields and a filter mask with an organic vapour filter. Overalls, such as laboratory coats or boiler suits, should be worn at all times. If the task involves moving weights, regardless of their size, protective footwear must be worn. After contact with oil and solvents, hands should be washed with a suitable hand cleanser to remove all traces. All electrical equipment must be disconnected from the supply before servicing. Where the service or maintenance involves the electrical system, only qualified electrical personnel should carry out the work.

3.5 Maintenance

To prevent sudden breakdowns, the machine requires regular maintenance, either daily or weekly, depending on its usage. Oil and grease should always be applied to the bearing to reduce friction and wear caused by rubbing.



Figure. 3: Assembly work of the groundnut roasting and peeling machine



Figure. 4: Pictorial view of groundnut roasting and peeling machine

4.0 DATA ANALYSIS AND PERFORMANCE EVALUATION OF THE GROUNDNUT ROASTING MACHINE

The experimental samples, before and after roasting groundnut mass, were analysed using both manual timing and machine-operated timing at various revolutions per minute. The data were coded and analysed with the Statistical Package for the Social Sciences (SPSS) version 25.0. Experiment samples were graphed using E-View 7.0 statistical software. Statistical techniques included descriptive statistics for the coefficient of variability, analysis of variance, and paired tests for comparison.

4.1 DATA ANALYSIS

Table 2: Shows the Operation of Roasting Groundnuts

S/NO	Weight of Groundnut Before Roasting (Kg)	Manual Time of Roasting Groundnut (mins)	Machine Time of Roasting Groundnut (mins)
1	1.00	30.00	15.00
2	2.00	40.00	20.00
3	3.00	55.00	30.00
4	4.00	75.00	45.00
5	5.00	90.00	50.00

Table 3: Shows the Operation of Peeling Groundnuts

S/N	Weight of groundnut before roasting (Kg)	Manual Time of Peeling Groundnut (mins)	Machine Operated Time of Peeling Groundnut (r/min)					Weight of Peeled Groundnut After Peeling (Kg)
			At 300	At 600	At 900	At 1200	At 1500	
1	1.00	15.00	2.70	2.00	1.90	1.50	1.30	0.97
2	2.00	22.00	3.50	3.10	2.40	1.90	1.50	1.97
3	3.00	30.00	4.50	3.10	2.90	2.10	2.10	2.95
4	4.00	45.00	5.80	4.20	3.50	2.95	2.95	3.80
4	5.00	58.50	7.60	5.10	4.50	3.20	3.90	4.50

Table 4: Tests of Between-Subjects Effects

Dependent Variable: Sample

Source	Sum of Squares	Df	Mean Square	F	Sig.
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BRM	366.953	4	91.738	2.024	.130
M/C operated	3989.747	5	797.949	17.604	.000
Error	906.557	20	45.328		
Total	5263.257	29			

a. R Squared = .828 (Adjusted R Squared = .750)

The experimental design for evaluating the machine's performance is based on the mass of groundnuts before and after roasting and peeling. Analysis of the machine's performance at various revolutions per minute, both manually and automatically, reveals that the machine's performance was statistically significant at all revolutions per minute, with a p-value of 0.000, which is less than 0.05 at the 5% level. The experimental fit was significant at 0.828, indicating an 82.8% correlation among the parameters. The mass before roasting is statistically significant, as the value of 0.030 is less than 0.05 at the 5% level. It is therefore concluded that the mass before roasting varies notably, and that operating the machine at different revolutions per minute produces different values after peeling.

CALCULATIONS

Mass of groundnut before roasting = 5 kg

Mass of groundnut after peeling = 4.50 kg

Mass of good groundnut = 3.89 kg

Mass of broken groundnut = 0.61 kg

$$\begin{aligned} \text{Efficiency} &= \frac{\text{Mass of groundnut after roasting and peeling}}{\text{Mass of groundnut before roasting and peeling}} \times 100 \\ &= \frac{4.50}{5.00} \times 100 = 90\% \text{ efficient} \end{aligned}$$

$$\begin{aligned} \text{Percentage of Breakage} &= \frac{\text{Mass of broken groundnut}}{\text{Mass of good groundnut} + \text{Mass of broken groundnut}} \times 100 \\ &= \frac{0.11}{0.89 + 0.11} \times 100 = 11\% \end{aligned}$$

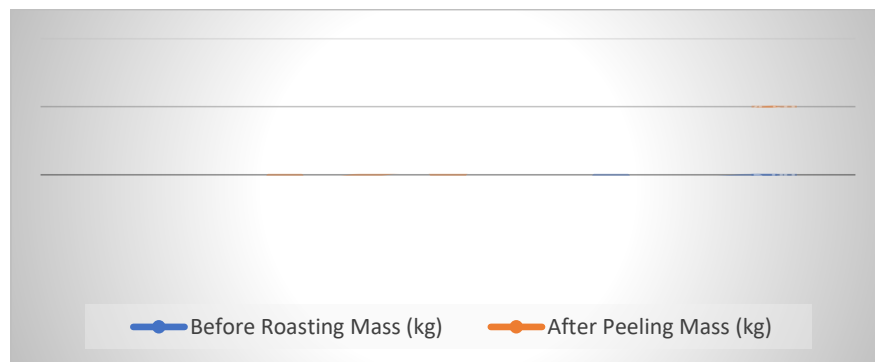


Fig. 5 : Shows the relationship between before groundnut roasting and after groundnut peeling

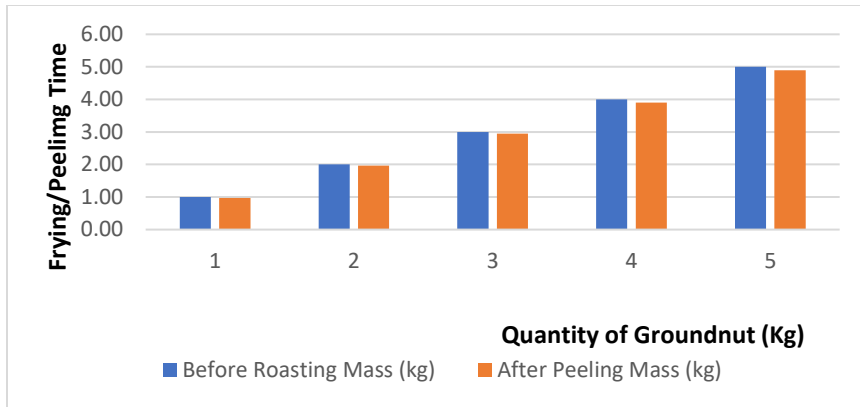


Fig. 6: Shows the relationship between roasting/peeling time and quantity of groundnut

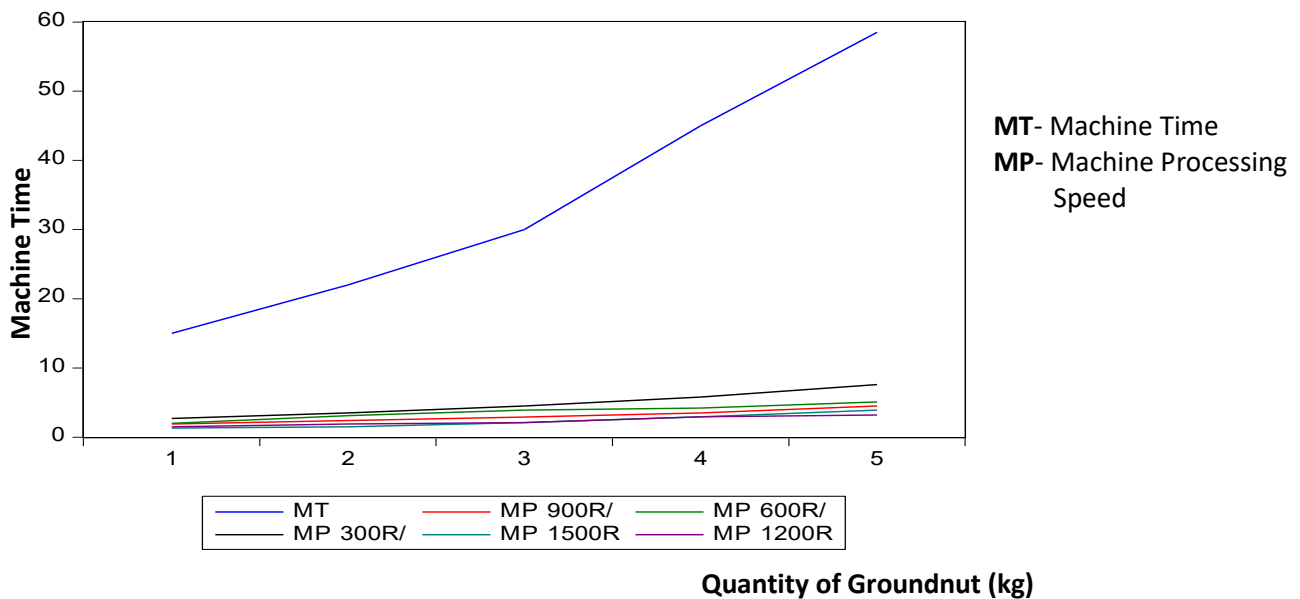


Fig. 7: A Graph shows the relationship between the machine time and the quantity of groundnuts peeled

The graph of MT and MP at various revolutions per minute shows that MP 1200r/min has the lowest processing machine speed, followed by MP 1500r/min, MP 900r/min, MP 600r/min, and MP 300r/min, respectively, compared to the manual machine processing time. Therefore, machine processing is much more efficient at MP 1200r/min and MP 1500r/min. Consequently, MP 1200r/min demonstrates the best processing capability for groundnut.

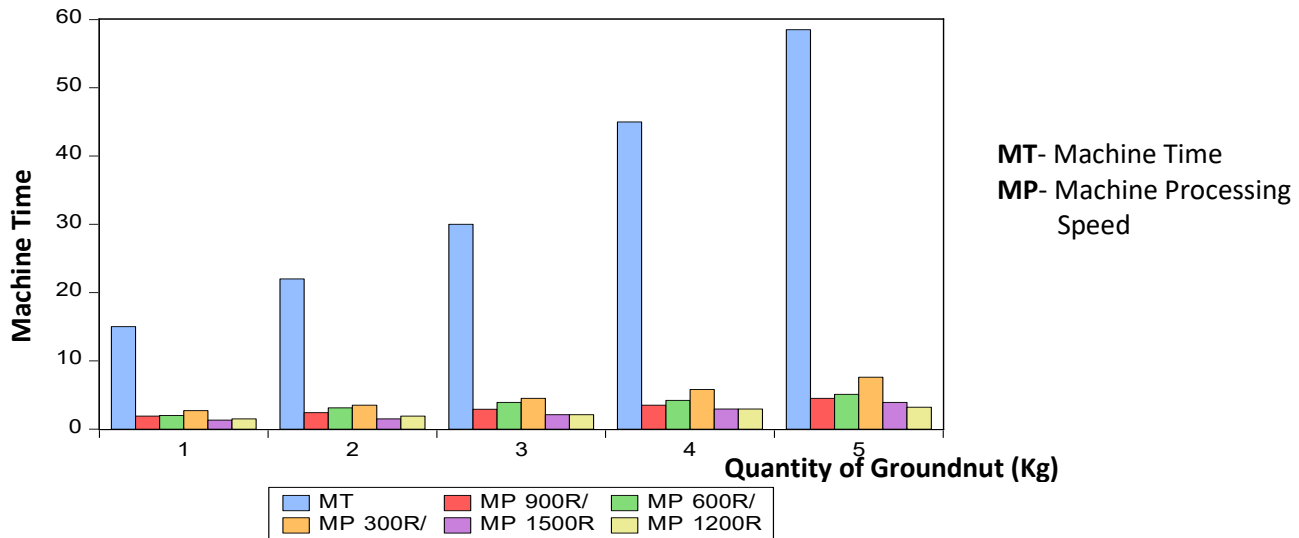


Fig. 8: A bar chart shows the relationship between machine time and the quantity of groundnuts peeled.

The graph of MT and MP at different revolutions per minute shows that MP 1200 r/min has the slowest processing machine speed, followed by MP 1500 r/min, MP 900 r/min, MP 600 r/min, and MP 300 r/min, in comparison to manual machine processing time. Therefore, the machine processing time is much more efficient at MP 1200 r/min and MP 1500 r/min. Consequently, MP 1200 r/min has the best processing ability for groundnuts.

4.2 RESULTS AND DISCUSSION

After the machine was fabricated, a thorough test run was conducted to evaluate its efficiency in roasting and peeling groundnuts. Tables 2 and 3 display the numerical results from the trials carried out during the experimental runs. To analyse the results systematically, the data were processed using the Statistical Package for the Social Sciences (SPSS), enabling robust statistical interpretation. This showed that the experimental processes had a good fit, with a correlation coefficient of 828, indicating an 82% relationship among the measured parameters. This high level of correlation highlights the interconnectedness of the variables involved in the machine's performance. Importantly, the mass measured before roasting was statistically significant (p -value = 0.030), well below the standard 5% significance level. This suggests a meaningful link between the initial mass of the groundnuts and the subsequent peeling efficiency.

The peeling chamber operated at different revolutions per minute, proving more effective than the traditional manual method of measuring mass before and after roasting. According to our findings, the peeling efficiency, based on the mass recorded before and after peeling, was approximately 52%. This moderate efficiency highlights some variability in the machine's output depending on factors such as its operating speed.

Furthermore, the results revealed considerable variation in mass before roasting, demonstrating that the machine's performance varies with changes in operational speed. In practice, while hand peeling typically takes 3 to 5 hours for 5 kilograms of groundnuts, this machine reduces the process to just 14 minutes. This marks a significant improvement in efficiency for both commercial and domestic use.

Additionally, the machine achieved an impressive 90% peeling efficiency, demonstrating that most of the product retained its integrity during processing. However, it is important to note that the broken-nut rate was 11%, which is a significant factor in assessing product quality. Overall, the data emphasise the potential of the newly developed machine to increase productivity while maintaining a high standard of output quality in groundnut processing.

4.3 Comparative Analysis between the Locally Fabricated Machine and the Manual Roasting and Peeling

A performance analysis of the machine was carried out to compare its efficiencies and throughput in groundnut peeling. The results, summarised in Tables 2 and 3, show that the locally developed machine outperformed the

manual peeling method across key areas, including peeling efficiency, throughput, and processing time. This emphasises the machine's effectiveness in optimising the peeling process and its potential to boost productivity in groundnut processing operations.

5. CONCLUSION

This study involved developing an improved groundnut roasting machine made from readily available materials, suitable for local production of roasted, peeled groundnut seeds. The machine is easy to operate, repair, and maintain. Its technology is more affordable than imported frying and peeling machines. It has low operational costs; it is compact, moderately weighted, produces minimal noise, and operates vibration-free. The experimental results showed a high fit (0.828), indicating an 82.8% correlation among the parameters. The mass of groundnuts before frying is statistically significant at 0.030, which is less than 0.05 at the 5% significance level. It is therefore concluded that the mass before roasting varies significantly, and that operating the machine at different revolutions per minute produces different peeling outcomes. The time needed to peel 5 kg of groundnuts by hand ranges from 3 to 5 hours, whereas the same process using this machine takes about 14 minutes. The machine has a peeling efficiency of 90%, a broken percentage of 11%, and a capacity of 19.6 kg/hour of peeled groundnuts. Clearly, peeling roasted groundnut seeds with this machine is more advantageous than doing so manually and represents an improvement over the previous design.

REFERENCES

1. Chandrakumar, K., Lakshmi, S., Umadevi, M., & Renganayaki, R. (2025). Influence of fatty acid contents and biochemical changes during storage of groundnut varieties cultivated in Tamil Nadu, India *Plant Science Today*, 12 (2) .1-9. DOI: 10.14719/pst.7727
2. Obojiofor, E. F., Hussein, J. B., Kareem, S. A., & Habila, H. (2022). *Effects of Processing Conditions on the Proximate and Sensory Qualities of Groundnut Cake (Kulikuli)*. *International Journal of Agricultural Research*. DOI: 10.3923/ijar.2022.192.200
3. Osunleti, S. O., Ajani, O. A., Olaogun, O., Osunleti, T. O., & Olatunde, E. O. (2022). Assessing the critical period of weed interference in groundnut *Arachis hypogaea* L. in Ogun State, south-western Nigeria. *Acta Fytotechnica et Zootechnica*, 25(3), 219–225. DOI:10.15414/afz.2022.25.03.219-225.
4. Abdussalam, M. S., Fagam, A. S., Sabo, M. U., & Shuaibu, Y. M. (2023). *Productivity of groundnut (Arachis hypogaea L.) as influenced by variety and spacing in Ningi LGA, Bauchi State, Nigeria*. *Journal of Agripreneurship & Sustainable Development*, 6(1), 65-72. DOI:10.59331/jasd.v6i1.393
5. Idris, Adekunle Lateef; Oyeniran, Oluyomi Johnson; Hassan, Babatunde A.; Adekunle, Adeniyi; Fatukasi, Samson O. (2023) — Development of Manually-Operated Groundnut Roasting Machine. *ABUAD Journal of Engineering Research and Development*, 6(1). DOI:10.53982/ajerd.2023.0601.11-j
6. Saanyol Ityokumbul Igbax, Daniel Swartling & Stephen Idem (2023). Impact of ultrasonic mixing on virgin and waste vegetable oils for biodiesel production. *Frontiers in Energy Research*, 11. DOI:10.3389/fenrg.. 2023.1268172
7. Rafiu, B. O., Omotayo, A. O., Lawal, I. O., & Aremu, A. O. (2025). Ethnobotanical uses of plants in Nigeria: an analysis of current research trends and patterns. *Journal of Ethnobiology & Ethnomedicine*, 21, 57. DOI: 10.1186/s13002-025-00788-y.
8. Adekunle, R. O., Owobayi, J. B., Olabiya, J. A., & Isa, J. (2025). The development of a kneader for a groundnut oil expeller. *Journal of Engineering Research and Reports*, 27(6), 352–360. DOI: 10.9734/jerr/2025/v27i61550.
9. Tjijptady, B. C., Rahman, R. Z., Putra, A. D., Permadi, L. C., & Meditama, R. F. (2024). Design of a peanut skin peeling machine based on professional Autodesk Inventor software. *G-Tech: Jurnal Teknologi Terapan*, 8(2), 1184–1192. DOI: 10.33379/gtech. v8i2.4134.
10. Idris, A. L., Oyeniran, O. J., Hassan, B. A., Adekunle, A., & Fatukasi, S. O. (2023).

Development of a manually operated groundnut roasting machine. *ABUAD Journal of Engineering Research and Development*, 6(1),45–56.DOI:10.53982/ajerd.2023.0601.11-j

11. Musa, A.; Adetola, O. A.; Olukunle, O. J.; Akintade, A. M. (2020). Modification and Optimization of Groundnut (*Arachis hypogaea*) Roasting Machine, *Journal of Scientific Research and Reports*, 26(5),71–83. DOI: 10.9734 /jsrr/2020/v26i530260
12. Lawson, O. S., Agbetoye, L. A. S., Olabinjo, O. O., & Olajide, O. G. (2023). *Design, fabrication, and performance evaluation of a groundnut seed dehuller as influenced by varietal differences. Journal of Engineering Research & Reports*, 25(6), 84–95 DOI: 10.9734/jerr/2023/v25i6925.
13. Okaiyeto, S. A., Oji, N., Unguwanrimi, Y. A., Sada, A. M., Ogijo, S. I., & Jonga, J. B. (2023). *Ergonomic evaluation of a manually operated groundnut roaster. FUOYE Journal of Engineering and Technology*, 8(2), 112–123. DOI: 10.46792/fuoyejet.v5i2.485.
14. Abankwa, E. O., Boadu, M. K., Amankona, E., & Fatahia, W. Z. (2025). *Design and Manufacture of a Manual Vertical Groundnut Roasting Machine*. DOI: 10.26437/ajar.v11i1.823.
15. Ayodele, M. B., Agbetoye, L. A. S., & Lawson, O. S. (2024). *Performance Evaluation of a Locally Fabricated Roasted Groundnut Dehuller. International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS)*, 13(1), 143–152. DOI: 10.51583/IJLTEMAS.2024.130112.
16. Mathobo, V. M., Onipe, O. O., Silungwe, H., Ramashia, S. E., & Anyasi, T. A. (2023). *Optimisation of the techno-functional and thermal properties of heat-moisture-treated Bambara groundnut starch using response surface methodology. Scientific Reports*. DOI: 10.1038/s41598-023-28451-0
17. Fasogbon and Adebo (2024). Properties and Metabolite Profiling of Bambara Groundnut Flour as Affected by Different Food Processing Conditions. *Applied Food Research*, Volume 4(4), Article 100389. DOI:10.1016/j.afres.2024.100389
18. Al-Azhar University, Faculty of Agricultural Engineering. (2021). An investigation of engineering properties of groundnut pods and kernels related to the design of post-harvest machines. *Al-Azhar Agricultural Sciences Journal*, 4(3), 144–160. DOI:10.21608/aasj.2021.226448

