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 meets 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 produces 41% of the total groundnut production in West Africa [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. It was reported by Yuanyuan *et al. [7] that roasted groundnuts are processed by heating them to 180 °C for approximately* 12–15 min or at 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.

Abdullahi [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 Gerald [9], Roasting enhances better extraction as it reduces the oil's viscosity, releases oil from intact cells and reduces the moisture content. The amount of oil produced will be significantly more if the oil is roasted correctly. However, excess heating during roasting results in low nutritional quality of protein. It also reduces the quantity of oil, and makes the colour of the oil extracted dark.

Abdulrahman [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.

Bashir [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 a power of 0.34 kW and had a throughput capacity of 27.47 kg/hr and an efficiency of 53%, respectively.
Sutejo and Adithya, [12], developed a groundnut peeling machine to generate a capacity 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).

Okaiyeto [13] developed a manually operated groundnut roaster with a roasting capacity of 0.92 kg/min, achieving a roasting efficiency of 98.9%. This was later followed by another effort by [14], who modified the existing roaster at

the Department of Agricultural Engineering, Bayero University, Kano. The modification was made to achieve better efficiency in groundnut roasting, improving its appearance and reducing drudgery during operation by adopting a new source of heat (charcoal) and by taking anthropometric dimensions of the sampled population to determine the machine's dimensions. The machine was tested using a 6.6 kg sample of groundnut, i.e. the same as used for the existing machine. The parameters evaluated indicate that the modified device has a roasting efficiency of 96.70%, a fuel consumption rate of 3.84 kg/hr, and an output capacity of 33.0 kg/hr.

In 2013, another researcher modified the existing de-skinning and winnowing machine. The machine is also manually operated, and the de-skinning efficiency of 83.52%, the cleaning efficiency of 79.67% and the scatter loss of 1.77% were recorded [15]. Despite this effort, limitations still existed on the machine, prompting [16] to modify it. Machine test running analysis revealed that the modified machine has a de-skinning efficiency of 92.51%, a cleaning efficiency of 81.01% and seed losses reduced to 1.36%.

Akintade and Bratte [17] developed a Performance Evaluation of a Roasted Groundnut Blanching Machine to determine the operating conditions that optimise the roasted groundnut blanching machine, making it easily adaptable for use by low and medium-scale farmers. In the performance evaluation conducted, the Blanching efficiency of the roasted groundnut machine at different blanch speeds of 100rpm, 150rpm, and 200rpm was 63.01%, 84.30%, and 89.46%, respectively. The mechanical damage rates were 91.39%, 80.00%, and 68.45%, respectively. Nevertheless, the machine has overcome the limitations of roasted groundnut blanching.
From literature searches conducted so far, different types of roasting and peeling machines have been developed to curb the problems encountered manually. However, among the issues are time wastage, labour cost, failure to provide a close collection, leaving the groundnut peels free to fall from a high distance, causing them to break into two or more pieces, and also requiring manual intervention by the user. Hence, there is a need to improve the groundnut roasting machine that can roast and peel the groundnut without burning or peeling, requiring minimal human intervention.

3. METHODOLOGY

This study development of an improved groundnut roasting and peeling consists of different parts which are; heater capacity, power requirement, feed hopper, shaft, stirrers, roasting cylinder, tilting handle, and the electrical part which included heating elements, temperature regulator, step down transformer (standard), DC electric motor, variable speed electric motor, universal joint coupling, etc. Standard values were used in developing the design and specifications. Fasteners and Arc welding were used due to their weld strength, durability, ease of operation, and cost.

3.1 Materials

The materials used for fabrication were selected after careful study of their physical, mechanical, chemical and aesthetic characteristics, as shown in Table 1, for this work. Due to economic considerations and material availability, high- and medium-carbon steel were mainly used, while stainless steel was used 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 conducted to determine the parameters necessary for selecting the appropriate grade and size of materials for the fabrication of various machine components. According to the specification, the total quantity 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 $V = \frac{M_g}{\rho} = \frac{5}{752.4} = 0.00664m^3$

The roasting chamber was designed to be cylindrical in shape, 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:

$V = \pi \frac{D^2}{4} H$ 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 [18].

The total energy required to roast the groundnut is given by

$E = M_g C_g \Delta T$ 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 [19], the most advantageous processing temperature for groundnuts is 140 °C. This is because nuts roasted above 140°C exhibited an excessive amount of redness.

Therefore, the energy adequate for roasting is:

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

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

Heat flux of the heating band

$$Q_1 = \frac{W}{\pi DL - 0.0254L} \quad (3.4)$$

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

Heat flux lost

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

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

Heat flux available

$$Q = Q_1 - Q_2$$

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

Power required for roasting

$$P = Q \times A \quad (3.5)$$

$$= 15606.67 \times 0.151 = 2353.43\ Watts$$

Surface area of a cylinder

$$A = \pi DL \quad (3.6)$$

where,

D is the diameter of the Cylinder
L is the length of the Cylinder
π is 3.142

$$= \pi \times 0.2 \times 0.24 = 0.151\ m^2$$

Time required for roasting

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

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

3.3 Design of Peeling Chamber

3.3.1 Force required to Peel Groundnut

To determine the force required to peel the groundnut, we have to choose the needed force to rupture the groundnut kernel. Any force less than this critical value is sufficient to peel the groundnut.

According to the research done by Iraj Begheri *et al [20], on the mechanical behaviour* of groundnut kernel under compressive load, it was deduced that the minimum force required to rupture 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:

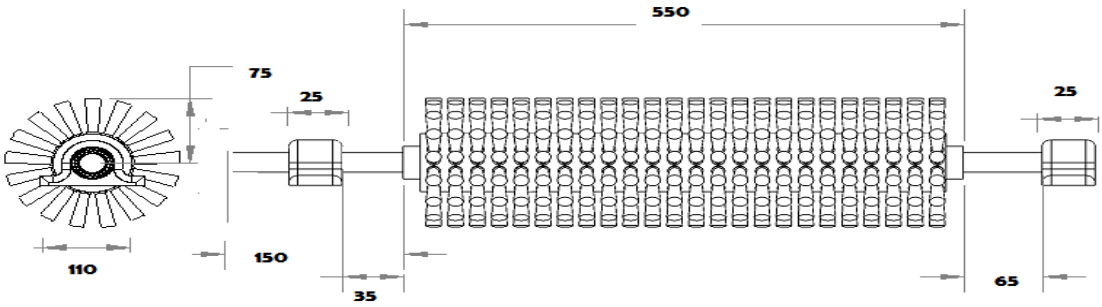


Fig. 1: Shows the Peeling Brush

From the geometry of the peeling brush above, we can determine the minimum dimension required to cover the entire groundnut being roasted. We recall that the volume of 5 kg of groundnut is 0.00664 m³.
Total volume that can be occupied by groundnut kernel is:

$V = volume\ of\ peeling\ chamber - volume\ of\ peeling\ brush$

For the length of the peeling chamber, a length of 600 mm was selected to accommodate the total length of the peeling brush and provide clearance for the brush's free rotation. To obtain the minimum diameter, we recall that:

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

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

$$D = \sqrt[2]{\frac{1}{0.6}\left(\frac{4\times0.00664}{\pi} + 0.11^2 \times 0.55\right)}$$

$$D = 0.158\ m = 158\ mm$$

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

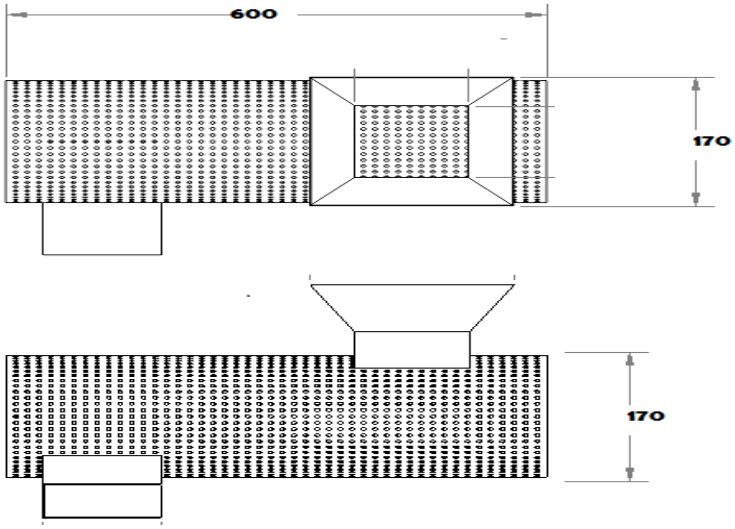


Fig. 2: Shows the Peeling Chamber

3.3.3 Speed Required to Peel Groundnut

Recall that the force required to peel a groundnut should be less than the minimum rupture force, which is 60 N. To achieve this, we recall that centrifugal force due to the rotation of the brush is given by:

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

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,

$$\omega = \sqrt{\left(\frac{2F}{M_g d}\right)} \quad (3.9)$$

$$= \sqrt{\left(\frac{2\times60}{5\times0.11}\right)} = 14.77\ rad/s$$

Speed is $N = \frac{60\omega}{2\pi}$

$$= \frac{60\times14.77}{2\pi} = 140\ rpm$$

3.3.4 Time Required Peeling the Groundnut

The time taken to peel 4.50 kg of roasted groundnut seed was 14 minutes (0.23 hours), i.e., the time when the red skin of the groundnut stopped coming out. The capacity of the machine is therefore;

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

3.3 Mode of Operation

Power is supplied to the machine from an external source. When the D.C electric motor is supplied with electrical power, it rotates, thus providing a rotating motion to the shaft, which in turn is transmitted to the stirrer to ensure that the groundnuts are stirred continuously and uniformly. The heating elements are also supplied with electrical power to generate the heat required for roasting. A heat regulator controls the heat generated. After allowing the machine to reach maximum temperature, the groundnuts are fed into the roasting chamber and allowed to roast.

The roasted groundnuts are poured into the hopper of the peeling chamber and allowed to cool. Afterwards, the groundnuts are peeled, as peeling also involves blowing out the red skin of the groundnut with the blower simultaneously. The groundnuts are then bottled and ready for sale or consumption.

3.4 Servicing Safety

Personnel in contact with oil and solvent may develop skin dermatitis. To reduce the risk of infection, apply barrier creams to the hands and wear suitable gloves. When using solvents, the areas should be well ventilated, preferably by a forced draught. Additionally, it is desirable that all personnel wear eye shields and a filter mask with an organic protection filter. Overalls, such as laboratory coats or boiler suits, should be worn at all times. If the service involves moving weights, regardless of their size, protective footwear must be worn. After contact with oil and solvents, hands should be washed with a 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 service.

3.5 Maintenance

To prevent sudden breakdown, 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 the rubbing action.

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

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

3.6 Cost Estimate

This is one of the factors guiding the selection of materials, which must be relatively cheap to meet the competitive market of the product. The production cost of this design includes manufacturing costs, product costs, labour, material costs, finishing costs, and other consumables. Table 2 below shows the material list and its costs.

Table 2: Bill for Engineering Measurement and Evaluation (BEME).

S/N	Description of items	Dimension (mm)	Quantity	Unit Cost (₦)	Amount (₦)
1	Stainless steel sheet	2 mm	½ length	30,500	30,500
2	Mild steel angle iron	50 mm x 50 mm x 4 mm	3	3,500	10,500
3	Stainless steel shaft	Ø30 mm x 900 mm	1	15,500	15,500
4	Stainless steel perforated pipe	Ø170 mm x 800 mm	1	13,500	13,500
5	Stainless steel shaft	Ø22 mm x 350 mm	1	6,500	6,500
6	Stainless steel flange	Ø80 mm x 8 mm thick	1	4,200	4,200
7	Heating elements, 1,200 Amp	Ø250 x 150 mm	1	8,500	8,500
8	Temperature regulator	-	1	6,500	6,500
9	Thermocouple	-	1	3,500	3,500

10	Step-down transformer	220 v – 110 v	1	1,500	1,500
11	D.C electric motor	110 v	1	8,000	8,000
12	Variable speed electric motor	220 v	1 length	145,000	145,000
13	Pillow block bearing	P206	2	2,500	5,500
14	Fibre glass (insulator)		Sum	2,500	2,500
15	Circuit controller		1	15,000	15,000
16	Stainless steel electrode	Gauge '10'	½ packet	6,500	6,500
17	Mild steel electrode	Gauge '10'	½ packet	1000	1000
18	Cutting disc	-	3	1000	3,000
19	Grinding disc	-	1	1000	1000
20	Paint		1cup	1,800	1,800
21	Miscellaneous	-	-	5,900	5,900
			TOTAL		**₦ 295,900**

RESULTS AND DISCUSSION

4.0 DATA ANALYSIS AND PERFORMANCE EVALUATION OF THE GROUNDNUT ROASTING MACHINE

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

4.1 DATA ANALYSIS

Table 3: 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 4: Shows the Operation of Peeling Groundnuts

S/NO	Weight of	Manual Time of	Machine Operated Time of Peeling Groundnut (r/min)	Weight of

	groundnut before roasting (Kg)	Peeling Groundnut (mins)	At 300	At 600	At 900	At 1200	At 1500	Peeled Groundnut After Peeling (Kg)
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 5: Tests of Between-Subjects Effects

Dependent Variable: Sample

Source	Sum of Squares	Df	Mean Square	F	Sig.
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 experiment 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 processes were significantly fitted 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

Efficiency = $\frac{\text{Mass of groundnut after roasting and peeling}}{Mass\ of\ groundnut\ before\ roasting\ and\ peeling}$ x 100

$$= \frac{4.50}{5.00} \text{ x } 100 = 90\% \text{ efficient}$$

$$\text{Percentage of Breakage} = \frac{Mass\ of\ broken\ groundnut}{Mass\ of\ good\ groundnut + Mass\ of\ broken\ groundnut} \text{ x } 100$$

$$= \frac{0.11}{0.89+0.11} \text{ x } 100 = 11\%$$

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

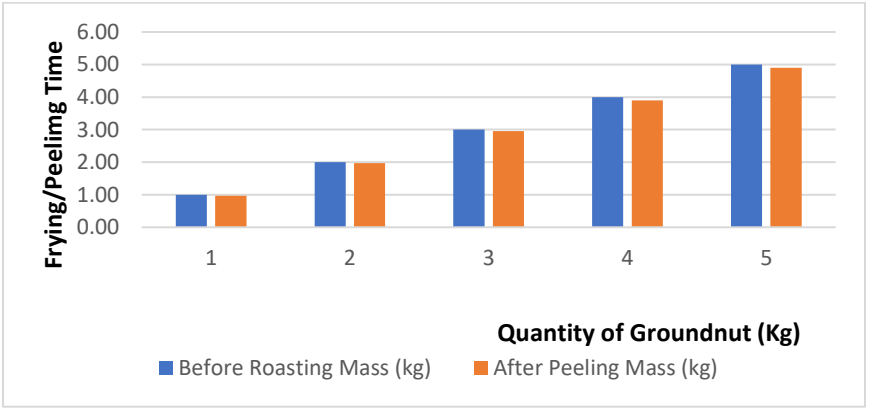
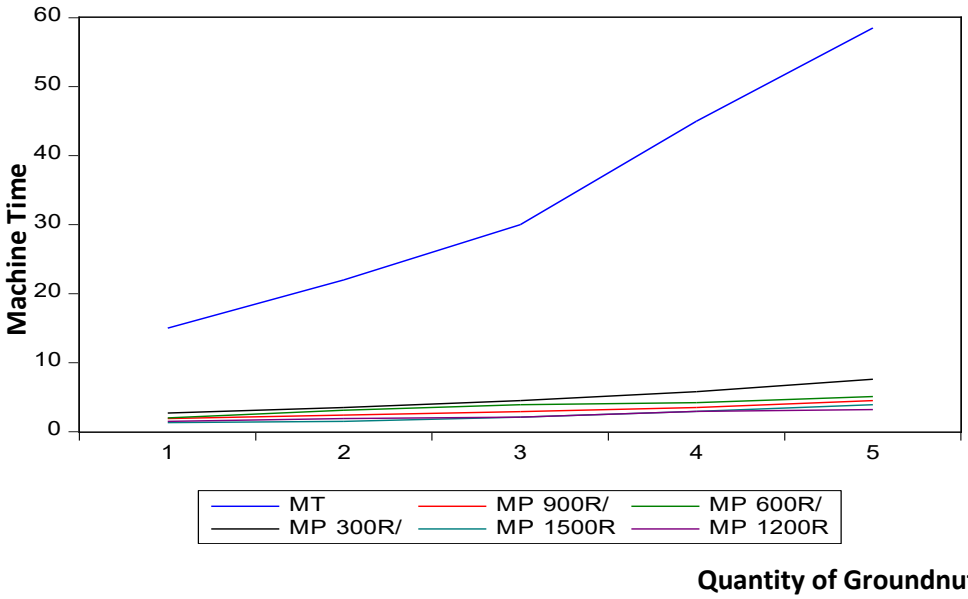


Fig. 6: Shows the relationship between roasting/peeling time and quantity of groundnut



MT- Machine Time
MP- Machine Processing Speed

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, the machine processing time is much more efficient at MP 1200r/min and MP 1500r/min. Hence, MP 1200r/min demonstrates the best processing capability for groundnut.

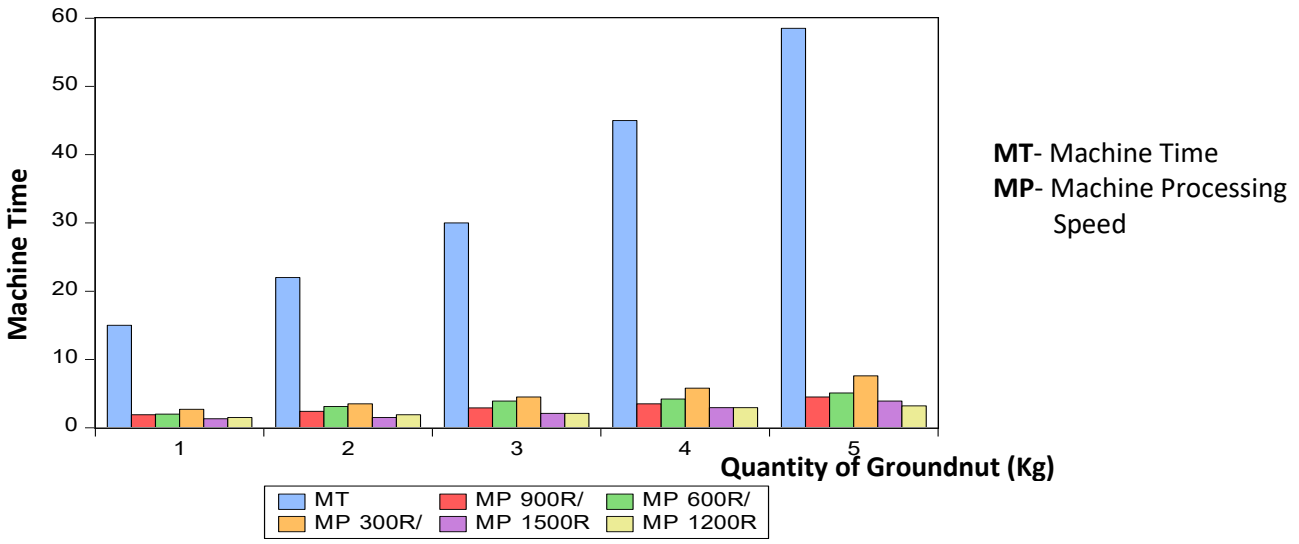


Fig. 8: A bar chart shows the relationship between machine time and the quantity of groundnuts peeled.

The graph of MT and MP at varying revolutions per minute indicates that MP 1200 r/min has the lowest processing machine speed, followed by MP 1500 r/min, MP 900 r/min, MP 600 r/min, and MP 300 r/min, respectively, compared to the manual machine processing time. Therefore, the machine processing time is significantly more efficient at MP 1200 r/min and MP 1500 r/min. Hence, MP 1200 r/m has the best processing capability for groundnuts.

The machine was test-run after fabrication to assess its performance. Tables 5 and 8 present the numerical results obtained from experimental runs. These results were analysed statistically using the Statistical Package for the Social Sciences (SPSS). The experimental processes fit well at 0.828, indicating an 82.8% association among the parameters, and the mass before frying is statistically significant since the value of 0.030 is less than 0.05 at the 5%

significance level. Additionally, the peeling chamber operated at varying revolutions per minute was most efficient compared to the manual method of measuring mass before roasting and after peeling in kilograms. The mass before roasting and after peeling, in kg, shows a moderate similarity at 52.7% efficiency. It was observed that the mass before frying varies, and the machine operating at different revolutions per minute produces different values after peeling. The time required to peel 5 kg of groundnuts by hand is approximately 3-5 hours, whereas the machine completes the task in 14 minutes. The machine achieves a peeling efficiency of 90% with a broken percentage of 11%.

5. CONCLUSION

This study involved the development of an improved groundnut frying machine fabricated using readily available materials, making it suitable for local production of fried and peeled groundnut seeds. The machine is easy to operate, repair, and maintain. Its technology is affordable and less costly compared to 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 with a value of 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 frying varies significantly, and that operating the machine at different revolutions per minute yields different peeling outcomes. The time required to peel 5 kg of groundnuts by hand ranges from 3 to 5 hours, whereas the same process using this machine takes approximately 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 groundnut. Clearly, peeling fried groundnut seeds with this machine is more advantageous than doing so manually and represents an improvement over previous designs.

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Figure 9. Machine for Plastic or Agricultural Processing

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Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.