

Modification and Performance Evaluation of a Manually Operated Drum Groundnut Roaster

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Abstract

The modification and performance evaluation of a Drum Groundnut seed Roaster was undertaken with the aim of achieving efficient roasting of groundnut by improving on the existing methods of roasting groundnut and eliminating the drudgery associated with the roasting of groundnut. The machine was designed, constructed and tested in the department of Agricultural Engineering, Federal University of Technology, Yola, Nigeria using locally available materials. It consists of three paddles (stirrer) attached to a shaft, which rotates and stir the groundnut seed constantly inside a drum. There is a charcoal tray and a fan assembly directly below the drum, which supplies the heat to the drum. The paddles and the fan assembly are directly driven through chain and sprocket. The frame is made of angle iron on which the entire assembly is mounted. The machine is operated manually through the handle. The machine performance evaluation was carried out using SAMNUT-10 (RMP-9), SAMNUT-10RMP-12 and ICGV-SM-93523 as Groundnut samples. The machine Roasting capacity was found to be 0.5kg/min. with roasting efficiency of 95%, material efficiency of 97.2%.and effective roasting time of 3 minutes. It was concluded that efficient and improved groundnut roasting could be better achieved with this machine than with the traditional methods of roasting which takes about 8-9 minutes.

KEYWORDS: Performance Evaluation, Drum roaster, Groundnut seeds

INTRODUCTION

Groundnut roasting is one of the most important tasks in the processing of groundnut seeds for the production of oil, cake or snack. The seed contains on the average about 40-50% oil, and is rich in protein, making it a valuable feed for poultry (Asiedu, 1989). The main commercial product of groundnut is oil, which is essential in the human diet; nutritionally they provide calories, vitamins and essential fatty acids in an easily digested form. Therefore the processes involves in the processing need to be given due consideration.

Groundnut seed processing is highly mechanized in developed countries. However, in the developing countries like Nigeria, and indeed in many West African Countries traditional method of processing

is the norm (Norde, *et al.*, 1982. This is very cumbersome and labour intensive. Ihekoronye and Ngoddy (1985) stated that traditionally, groundnut seeds are roasted by constant stirring of the groundnut seeds in an open mild steel pan, circular pans, or locally made clay pot supported over an open wood fire for about 8 - 9 minutes. This technique is rather hazardous and causes a great deal of discomfort to the operator due to constant contact with heat and smoke from the fire. It also becomes extremely difficult to predict the actual time of roasting. The process is time consuming and this often leads to some losses in both quality and quantity during processing. On the other hand, modern roasting machines are in existence, Mechanical roasters such as cashew, cowpea, cake

and peanut have been developed to reduce the drudgery of roasting to a great extent but the traditional roasting is still predominant due to high cost of the special roasting equipment. The high cost of obtaining special roasting equipment has become inaccessible to most people. Even where it exist the source of power, which is electricity, is not consistent (Peter, 1985). Thaddeus, (2004) designed and constructed a prototype groundnut seed drum roaster for small-scale farmers using charcoal as a source of heat. The machine has a belt and pulley as driving mechanism, a drum capacity of 5.3kg, Roasting capacity of 0.43kg/min, and roasting efficiency of 90% with an average roasting time of 6 minutes. However, the performance of this machine was not satisfactory because of the high average roasting time of 6 minutes and the operational efficiency of 90% average is judged to be low. Therefore, there is the need to modify the machine in order to improve the performance by replacing the belt and pulley drive with a chain and a sprocket, the suction fan with an axial fan and increasing the number of stirring paddles from two to three. This is because the belt and pulleys cannot withstand the heat generated from the roaster. Chain and sprocket has the ability to transmit power in tension without slippage and at low speed, which can be easily varied. It also transmits more power than the belts and can be operated under adverse temperature and atmospheric condition. Chains give higher transmission efficiency of up to 98% (Khurmi and Gupta, 1979).

The objectives of the modification of this drum groundnut roaster are as follows:

- (a) Minimum cost compatible with efficiency.
- (b) Ease and safety of operation and inspection.

The modified drum groundnut seed roaster was redesigned, constructed and tested and the results of the performance evaluation of the machine are reported in this paper.

A very important aspect of the drum Roaster is the source of heat, which is charcoal. Charcoal is cheap and easily available in almost every home obtained from wood fire. The machine will greatly reduce the dependence on wood fire that encourages deforestation and the wastage of charcoal in the homes. The machine also reduces seed damage during processing. It is also believe that the machine will also encourage small and medium scale farmers.

MATERIALS AND METHODS

Selection of materials used in construction of the modified component of the Roaster placed emphasis on some criteria like durability, strength, availability, size and weight of such materials. The modified components include:

The belt and pulley; this is replaced by a chain and sprocket because chain drives gives a better resistance to heat and does not wear out easily and can be operated under adverse temperature and atmospheric condition. The important variable that was considered in the design is the pitch, rotational speed, speed ratio and the distance between the sprockets. This was compared to that of the pulley in order to obtain the required speed of operation.

The suction fan is replaced with an axial fan, which gives better fanning effect on the charcoal at low

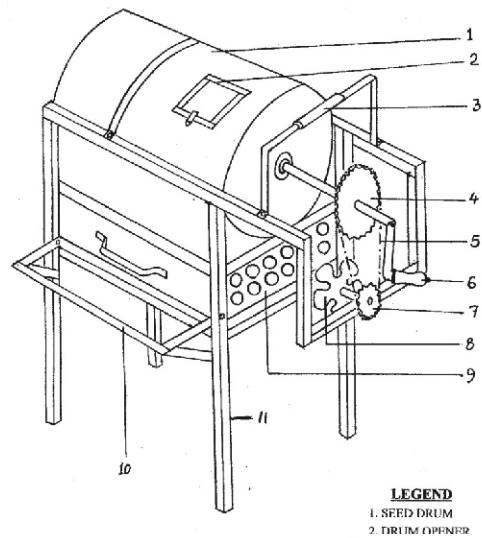
speed. The stirring blade was also changed from two to three blades, so as to give a better mixing action of the groundnuts, thereby reducing the effect of over roasting.

Description of the Machine

The drum roaster consists of the drum that serves as a hopper, the charcoal tray, rollers chain, two sprockets, axial fan, off loading handle and supporting frame (Fig. 1&2).

The metering unit consists of the handle on which the paddles used to stir the groundnut inside the drum are attached. The transmission unit consists of the two sprockets mounted on the shaft. Fan used to supply air to the charcoal tray is attached. The machine is operated through the handle. The fan

located directly opposite the charcoal tray is driven directly from the chain and sprockets and supply air to the charcoal tray. The handle is used to off load the content by lifting the handle up.



LEGEND
1. SEED DRUM
2. DRUM OPENER

Fig 1: Assembly Drawing of the Modified Drum Groundnut Seed Roaster

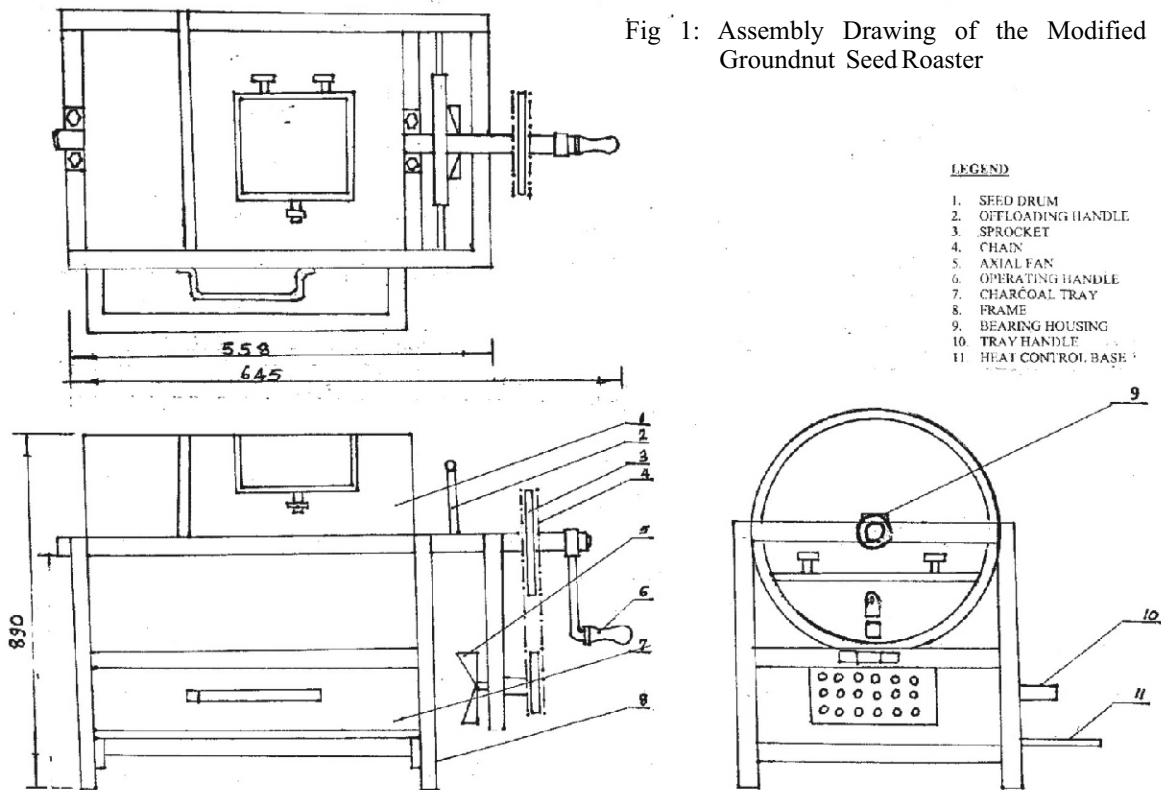


Fig. 2: Orthographic View of the Drum Groundnut Seed Roaster

Performance Evaluation

Performance evaluation of the drum roaster involves evaluation of the machine capacities and efficiencies. Performance parameters investigated included the throughput capacity (kg/min.), material efficiency (%), and effective time of roasting.

The materials used for testing the performance of the machine are three varieties of Groundnut seed samples viz; (SAMNUT-10RMP-9, SAMNUT-10RMP-12, and ICGV-SM-93523), stop watch, weighing balance, and wood charcoal.

The available quantity (1.5kg) of Groundnut samples was fed into the drum through the opening. Burning charcoal in the charcoal tray was placed under the drum and rotating the handle that stirs the groundnut seed in the drum and also drive the fan through the sprocket that supplies constant air to the charcoal tray to maintain constant heat supply to the machine.

The time taken to roast the groundnut was noted using the stopwatch. This procedure was replicated three times for each of the three varieties of groundnut (SAMNUT-10RMP-12, SAMNUT-10RMP-9 and ICGV-SM-93523). This was done in order to determine the Roasting capacity, and efficiency, using standards and procedures for determining performance data from crop processing machines as reported by Smith and Wilkes (1990). The machine's performance parameters were evaluated from the test results using equation 1, 2 and 3 below:

$$\text{Roasting capacity (kg/min)} = Q_f/t_n \text{-----(1)}$$

$$\text{Material efficiency (\%)} = \frac{Q_f - Q_t}{Q_f} \times 100 \text{-----(2)}$$

$$\text{Mechanical damage (\%)} = \frac{Q_b}{Q_f} \times 100 \text{-----(3)}$$

Where:

Q_f = Quantity of groundnut in the drum (kg)

t_n = time taken to roast groundnuts (min)

Q_t = quantity of groundnut broken (kg)

Q_b = quantity of groundnut burnt (kg)

RESULTS AND DISCUSSION

The performance evaluations mean results obtained with the machine for the three varieties of Groundnut seeds are shown in Table 1. The full performance results are shown in Tables 2, 3 and 4. Table 1 shows that 1.39kg groundnut (SAMNUT-10RMP-9) sample was roasted in an average time of 2.5 minutes with 0.041kg broken and 0.025kg burnt. The machine has a Roasting capacity of 0.56kg/min and material efficiency of 97.2%. This implies that about 97.2% of quantity of groundnut in the drum was efficiently roasted while 2.8% was burnt (damaged). This could be attributed to in proper sorting and grading of the seeds.

The machine performance parameters for groundnut seed sample (SAMNUT-10RMP-12) in Table 1 show very little variation in roasting capacity of 0.53kg and material efficiencies of 96%. The mechanical damage is 2.6% with effective time of 2.8 minutes.

Table 1 also shows the performance parameters for

Table 1. Performance Parameters of the Modified Drum Groundnut Roaster using three Groundnut seeds Varieties.

S/No.	Variety	Roasting Capacity Kg/min	Material Efficiency (%)	Mechanical damage (%)	Effective time of roasting (min)
1.	SAMNUT10RMP-9	0.56	97	0.03	1.8
2.	SAM NUT RMP-12	0.53	96		2.6
3	ICGV-SM-93523	0.42	93		4.1
	Mean	0.50	95		2.8

2: Performance Evaluation Results of SAMNUT-10 (RMP-9)

Wt of g/nut in the drum (kg)	Effective time of roasting (min)	Wt of wholly roasted g/nut (kg)	Wt of g/nut broken (kg)	Wt of g/nut burnt (kg)
1.37	3.0	1.31	0.03	0.02
1.42	2.0	1.28	0.06	0.03
1.39	2.5	1.23	0.04	0.03
4.18	7.5	3.82	0.12	0.08
1.39	2.5	1.27	0.04	0.04

Table 3: Performance Evaluation Results of SAMNUT-10 (RMP-12)

Wt of g/nut in the drum (kg)	Effective time of roasting (min)	Wt of wholly roasted g/nut (kg)	Wt of g/nut broken (kg)	Wt of g/nut burnt (kg)
1.51	3.0	1.40	0.03	0.02
1.42	2.5	1.27	0.07	0.04
1.53	3.0	1.33	0.08	0.05
4.46	8.5	3.99	0.18	0.12
1.49	2.8	1.33	0.06	0.04

Table 4: Performance Evaluation Results of ICGV-SM-93523

Wt of g/nut in the drum (kg)	Effective time of roasting (min)	Wt of wholly roasted g/nut (kg)	Wt of g/nut broken (kg)	Wt of g/nut burnt (kg)
1.46	3.0	1.24	0.03	0.08
1.43	4.0	1.18	0.13	0.03
1.50	3.5	1.31	0.12	0.07
4.39	10.5	3.73	0.30	0.18
1.46	3.5	1.24	0.10	0.06

ICGV-SM-93523 groundnut sample. It shows that 1.46kg of groundnut was roasted in an average time of 3.5 minutes. The result shows a significant variation from the other two varieties SAMNUT-10RMP-9 and (SAMNUT-10RMP-12). The throughput capacity is 0.42kg/min, material efficiency of 93% and mechanical damage of 4.1%. The mean values of the performance parameter

evaluated for the three varieties of groundnut shows that the machine on the average has a throughput capacity of 0.50kg/min, material efficiency of 95% with a mean time of 3 minutes.

This implies that the drum roaster can roast about 24kg of groundnut in 47 minutes, which is a better result over the S and R portable groundnut roaster that has an average roasting capacity of 10kg in 47

minutes as reported by Thaddeus (2004). It also has roasting capacity of 0.5kg/min better compared with the hand operated peanut roaster of 0.067kg/min throughput capacity as reported by Thaddius (2004).

CONCLUSION AND RECOMMENDATION

The development of the groundnut drum roaster was carried out with the aim of improving the roasting efficiency and eliminating the drudgery associated there with. Roasting capacity of the Groundnut varieties; SAMNUT-10RMP-9, SAMNUT-10RMP-12, and ICGV-SM-5238 were up to 0.56kg/min, 0.53kg/min and 0.42kg/min respectively. The mechanical damage was up to 1.8%, 2.6% and 4.1% respectively. The material efficiencies for the three varieties were up to 97%, 96% and 93% respectively. On the average the roaster has a Roasting capacity of 0.5kg/min. mechanical damage of 2.8% and material efficiency of 95% as shown on table 1. The machine has overcome the limitations of the traditional method used with open firewood commonly used in Nigeria. Therefore, efficient and precise groundnut roasting is achievable with the groundnut drum roaster. To minimize mechanical damage and the effective time of roasting, it is suggested that the charcoal should be properly lighted before putting under the drum. Also the seeds should be properly winnowed to remove the bad one. This will reduce the effective time and the machine damage.

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