

# Design, Fabrication and Performance Evaluation of a Low-Cost Portable Roasted Groundnut Seeds Dehuller

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## Abstract

Traditionally, the manual dehulling (removal of peels) of roasted groundnut seeds has been a time-consuming and tedious operation. A low cost roasted groundnut seeds dehuller was therefore designed, fabricated and tested. The machine consists of a hopper made of stainless steel, a dehulling unit consisting of a shaft with rubber spikes arranged on it and which rub the groundnut seeds against a housing, a discharge unit for collection of dehulled seed, a fan for blowing away the chaffs and a frame made of mild steel. The overall size of machine is 235mm x 200mm x 250mm. The result obtained after testing the machine shows that at four testing trials, the average dehulling efficiency obtained are 81.83% while cleaning efficiency and machine throughput are 97.02% and 37.78kg/hr respectively. The machine total cost is ₦35,500.00.

## Introduction

Groundnut (*Arachis hypogaea* L.) is an important grain legume that grows in wet conditions in semi-arid regions of the world (Rao, 1980). As major crop in most of the tropical and subtropical regions, groundnut ranks 12th in the world crop production. It is grown in all continents with a total area of 24.6 million hectares, and a production of 41.3 million tons in 2012 (FAO, 2013). There are two main types of groundnut: the America groundnut (*Arachis hypogaea*), and the Africa groundnut, the Bambara nut (*Voandzeia subterranean*). Both are grown in Western Africa as a protein source. Groundnuts also contain sufficient quantity of carbohydrates and fats. The America groundnut grow 30-40cm high and do not spread. The West Africa groundnut is shorter and run along the ground from 30-60cm. Yields of kernels generally range from 0.5-4.0 tons/hect. In the developing countries, where 80 % of the crop is produced, the average yields are around 1 tons/hect (Shankarappa et al, 2003; Hommons, 1994). Africa, with 11.7 million hectares of land

used for groundnut production and 10.9 million tons of annual production in 2012 is second only to the American continent (FAO, 2013). De-hulling (removal of seed coat from a grain) after the kernel has been roasted is vital in the final processing of such seed for human consumption. For roasted groundnut, de-hulling also means de-chaffing. This is traditionally done manually by the women and children by rubbing the groundnut kernels in between their palms. The cleaning is achieved by using mouth to blow away the chaff from the kernels while the kernels are still in their palms, while the de-hulling process for other legumes such as sorghum and millet is accomplished either traditionally by hand pounding of tempered grain using pestle and mortar or mechanically using abrasive de-hullers (Munck et al, 1982). There have been several attempts to make machines that de-hull legumes and other seeds such as sorghum, cowpeas, maize etc. Between 1972 and 1976, the then Nigeria's Federal Ministry of Agriculture and Natural Resources and the North-Eastern State Ministry of Agriculture and Natural Resources established a complete processing plant consisting of de-huller, hammer mill and a diesel engine to drive the equipment in Maiduguri (Dovlo et al, 1976). Most groundnut dehulling machines fabricated in Nigeria are either too expensive or not efficient, and as a result of high demand for groundnut and ground product in the world market today, the traditional method of using bare hand to dehull and winnowing to separate groundnut seeds are time and labour consuming. Since the local method of production could not match the demand there is the need to develop a machine which will remove drudgeries, reduce the number of labour required and the time for dehulling and winnowing kernel from the husk or skin of the groundnut. Hence, a portable roasted groundnut seeds dehuller was designed and fabricated.

## **Methodology**

### **Description of the machine**

The isometric and exploded views of the machine are shown in Fig. 1 and Fig. 2 respectively. The roasted groundnut dehulling machine consists of the following components:

- i. The Hopper: The hopper is pyramidal in shape and suitable at the left to top hand side of the machine. It is the inlet in which the roasted groundnut seeds were admitted into the

dehulling chamber. The hopper is fabricated from stainless steel of dimension 200mm x 80mm x 260mm.

- ii. The Dehulling Unit: This is the core of the machine; it houses the shaft which bears the
- iii. spikes that rub the roasted groundnut seeds.
- iv. Discharge Unit: This is the point where the kernel and chaff from the dehulling unit are collected separately. The machine has two discharge outlets, one for the kernels and other for the chaffs.
- v. Machine Frame: The frame is the mounting support of all the components of the machine. Therefore, while it is desirable to minimize the weight of the frame, it should be sufficiently strong and rigid.

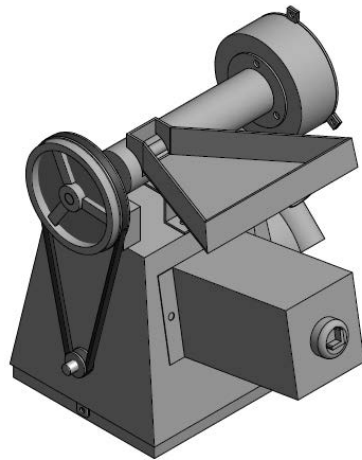


Fig 1: Isometric View of the Groundnut Seed Dehuller

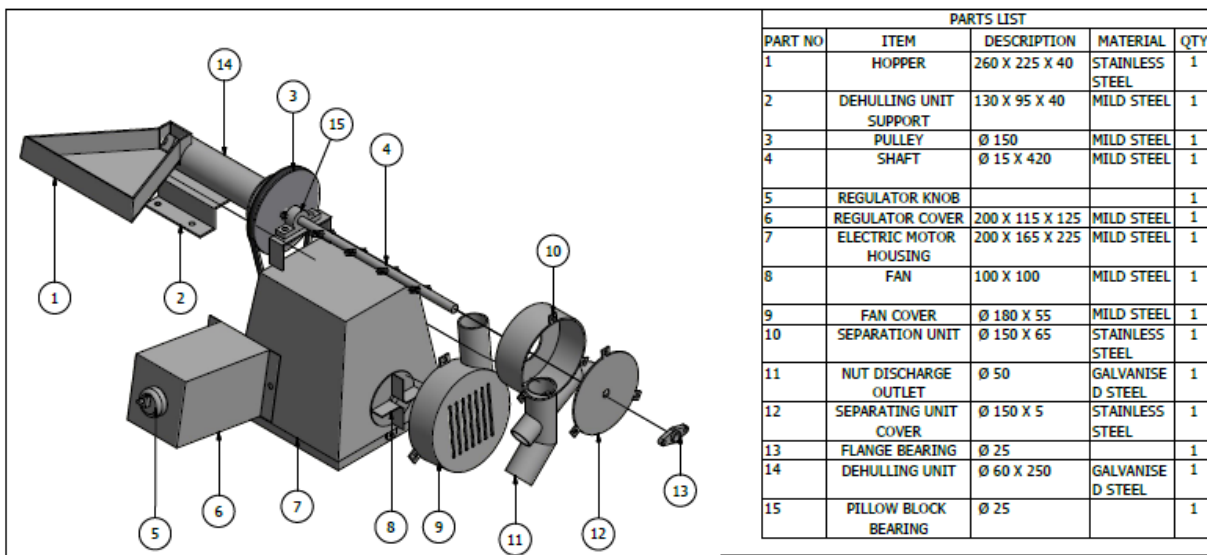


Fig 2: Exploded View of the Groundnut Seed Dehuller

## Design of Components

The key components of the machine such as drive shaft, hopper, dehulling unit, and length of belt were designed and the results of design calculations are given as follows:

Diameter of the drive shaft = 20mm

Length of belt = 430mm

Power required to drive dehulling unit = 0.44hp

## Mode of Operation of The Machine

The dehulling operation of the machine is achieved by rubbing and rotation forces. The main function of the roasted groundnut seeds dehulling machine is to remove the husk (the thin coated skin of the groundnut seed) from the seed and separate the kernel from the chaffs (husks of the seeds). The hopper serves as the feeding mechanism through which the roasted groundnut seeds are fed into the machine, after the feeding, the spikes coupled with impeller serve as conveyor and at the same time rub the seed with cylinder wall, and the roasted seeds to the outlet. As the conveying and rubbing progress, dehulling of the roasted groundnut seeds takes place. Finally, the dehulled seeds and the chaffs (skin) are collected through different outlets. The machine is incorporated with a fan to separate the dehulled seeds and chaffs (skin) as the dehulled seeds are dropping from the dehulling unit. The machine is made up of two units at the discharge point, namely; the kernels discharge unit and chaffs discharge unit.

## Test Procedure and Results

The machine was run with constant power of 1,1025kw (1.5hp) electric motor. Different samples of roasted groundnut seeds were measured in grams using electronic weighing balance before being taken to machine dehuller. The weights are; 110.1g, 107.1g, 110.7g and 107.4g. The total weight of each sample was measured before dehulling and after dehulling. The discharge obtained were separated into different five categories such as: (i) Fully dehulled (ii) Undehulled

seeds (iii) Half dehulled seeds (iv) Splitted seeds (v) Chaffs. Each category was measured one after the other using electric weighing balance. Table 1 shows the result obtained for the four test samples

Table for the tester samples are:

Test Sample	Weight of Sample (g)	Dehulling Time (s)	A Fully Dehulled seed (%)	B Undehulled seeds (%)	C Half Dehulled seeds (%)	D Splitted seeds (%)	E Chaffs (%)
1	110.10	10.00	75.60	4.35	5.45	6.00	3.60
2	107.10	11.10	74.50	.70	5.10	5.30	3.40
3	110.70	10.50	80.80	8.40	4.00	4.30	2.50
4	107.40	9.50	75.60	11.30	5.70	5.00	2.40
<b>Average</b>	108.83	10.37	81.83	5.19	5.06	5.15	2.98

Based on the result obtained in Table 1, the following parameters were calculated to give the performance of the machine:

(a) Dehulling efficiency = Average of A = 81.83%

(b) Cleaning Efficiency = (1 – Average of E)% = (1 – 2.98)% = 97.02%

(c) Machine Throughput =  $\frac{\text{Average Weight of Samples (kg)}}{\text{Average Time Taken (hr)}}$

$$= \frac{108.84 / 1000}{10.37 / 3600}$$

$$= 37.78 \text{ kg/hr}$$

## Conclusion

A roasted groundnut dehulling machine was designed, fabricated and tested. Low cost available materials were used in fabricating the machine. Initial test of the machine showed that it has a dehulling efficiency and cleaning efficiency of 81.83% and 97.02% respectively. The throughput of 37.78kg/hr showed that the machine is very efficient in saving the manual labour required in dehulling roasted groundnuts.

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