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(RESEARCH ARTICLE)

Effects of some test parameters on dehulling efficiency of a roasted groundnut seed dehulling machine

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Abstract

Groundnut (Arachis hypogeae. L) is an important oil seed grown in over 100 countries for its nutritional value. In order to improve its storability and value, various ways of processing the seeds have been adopted among which is the roasting and removal of husk or rind from the roasted groundnuts. The process of removing of groundnut husk is mostly done manually and inappropriate for large scale processing. In order to improve groundnut seed husk dehulling process through mechanization, a roasted groundnut seed dehulling machine was developed and the effects of operating speed of the machine and moisture content of the seed on the on the efficiency of the machine was studied. 1kg of the roasted groundnut in five replicates with moisture content of 1.4, 1.6, 1.8, 2.0 and 2.2 % (w.b) respectively, was fed into the machine at different speed of 30, 35, 40, 45 and 50 rpm for each replicate. The machine had the best dehulling efficiencies of 80%, 78%, 77%, 90% and 73% at the lowest speed (30 rpm) while the lowest efficiency of 57%, 49%, 53%, 52% and 46% was recorded at the highest speed (50 rpm) in all moisture content (1.4, 1.6, 1.8, 2.0 and 2.2%) respectively. The best performance efficiency of 90% was gotten at 30 rpm and moisture content of 2.0 % (w.b). Hence, an optimum operating condition was established for the machine.

Keywords*:* Dehulling; Efficiency; Moisture Content; Roasted Groundnut and Speed.

1. Introduction

Groundnut (*Arachis hypogeae. L*) is the 13th most important food crop; 4th most important source of edible oil and 3rd most important source of vegetable protein in the world [7;17]. The Portuguese introduced it into African continent from Brazil in the 16th century [2; 8]. It is a member of the genus *Arachis* in the family of *Leguminosae* (*Fabaceae*). The production rate world-wide is over 270,000 metric tons annually [12].

Groundnut (Figure 1) is grown on 26.4 million hectares worldwide with a total production of 36.1 million metric tons, and an average yield of 1.4 metric tons/ha [5]. According to [6; 7], groundnut is grown in nearly 100 countries with China, India, U.S.A, Indonesia, Nigeria, Myanmar and Sudan as major producers.

Groundnut can thrive very well in all the states of Nigeria. Only 6 million hectares or 55,500 km^2 (5.1%) of the arable land are used for cultivating groundnut. With this little cultivated portion, Nigeria is ranked 1st in Africa and 3rd in the world after China and India in the production of groundnut with around 3 million metric tons in 2017 [10].

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a

b

Figure 1 (a) Groundnut Plant (b) Groundnut Seed

According to [6], groundnut seeds are nutritional source of Vitamin E, niacin, falacin, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium. There are two parts of groundnut that are the edible: roots and seeds. The root can be processed in a variety of ways, like roasting, baking, boiling, frying or drying for flour. The small seeds can be substituted for beans or lentile in soups and stews [12].

Groundnut kernels are consumed directly as raw, roasted or boiled forms. Oil extracted from the kernels is used as culinary oil. The vines are used as fodder for cattle [9]. Groundnut is useful in treatment of hemophilia and can cure stomatitis; prevents diarrhea and is beneficial for growing children, pregnant and nursing mothers [4]. The crop is used as industrial materials for producing oil-cakes and fertilizer. All parts of the groundnut plant are used in one way or the other. These multiple uses of groundnut plant make it important for both food and cash-crop for the available domestic or worldwide external markets in several developing and developed countries. Globally, 50% of the produce is used for oil extraction, 37% for confectionery use and 12% for seed purpose [17].

Groundnut processing is basically the transformation of the primary agricultural products (raw groundnut) into other finished commodities like groundnut oil, cake and animal feed among others. The milling of the product yields edible oil which can be refined to get vegetable oil and groundnut cake which is a valuable input in the preparation of animal feed and as such can be sold to animal feed millers. Therefore, groundnut processing can lead to reduction in food wastage, enhanced food security and improvement of livelihood of low income people [6; 15; 16].

Large quantities of groundnuts are lost annually due to lack of storage facilities and simple mode of processing [13]. In order to improve its storability and value, various ways of processing the seeds have been adopted among which is the roasting and removal of husk or rind from the roasted groundnuts. This process is mostly done manually by 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 [11]. This is inappropriate for large scale processing and may lead to post-harvest losses and drudgery.

Efforts have been made to improve this process through mechanization: [3] worked on roasted groundnut blanching machine using brush in the blanching unit which caused splitting of the groundnut seed. The machine was designed with the aim of reducing drudgery associated with manual blanching of roasted groundnuts. Three operating parameters: blanch clearance, blanch speed and feed rate, were considered for the purpose of the research. Three levels each of feed rate, brush speed and blanch clearance were also compared. Blanch clearances were varied from 10mm to 20mm at an increment of 5mm for three different feed rates of 0.2kg/hr, 0.4kg/hr and 0.6kg/hr respectively, while blanch speed was varied from 100 rpm to 200 rpm with an increment of 50 rpm. It was concluded that roasted groundnut blanching could be best achieved with the machine when the feed rate, blanch clearance and blanch speed were regulated to 0.2 kg/hr, 0.8 mm and 200 rpm, respectively. [13] of the Mechanical Engineering Department, Federal University of Technology, Minna, Nigeria, also worked relatively to mechanizing the process using spikes in the dehulling chamber which also cause much splitting of the dehulled seeds.

The performance evaluation of a Roasted Groundnut Seed Dehulling Machine designed and constructed in the Department of Mechanical Engineering, Ekiti State University, Ado-Ekiti, Ekiti state, Nigeria was carried out to assess the effects of some test parameters on its efficiency. This is to ascertain the optimum working parameters for the machine.

2. Material and methods

2.1. Description of the Machine

The roasted groundnut dehulling machine (Figure 2) consists of the following components:

Figure 2 Roasted Groundnut Dehulling Machine

Hopper: a stainless pyramidal shaped hopper of dimension (200 x 80 x 260) mm and is positioned at the top left hand side of the machine.

Dehulling Unit: This is the core of the machine, it consists the shaft which bears the dehulling drum having the conveying worm wound around it at regular pitch. Housing the dehulling drum is the cylindrical padded surface which counteracts the movement of the roasted groundnut seeds with a very minimal abrasive impact, thereby dehulling it.

Discharge Unit: This is the point where the roasted groundnut seeds and the chaff from the dehulling unit are collected separately. The dehulled seeds are collected down the spout, while the chaff is blown away and beyond the dehulled seed via an axial fan incorporated under the spout.

Machine Frame: The frame is the mounting support of all the components of the machine. It is made from mild steel of (39 x 39 x 3) mm specification for strength, rigidity, and stability.

2.2. Materials

some of the materials used for the experiment include, a roasted groundnut dehulling machine, OHAUS Scout Pro SPU4001 digital weighing scale with accuracy range given as (±0.1%+1 digit), medium density polyethylene nylon, bowls, and tachometer.

2.3. Sample Preparation

The groundnut seeds were roasted and conformed to 1.4, 1.6, 1.8, 2 and 2.2 % moisture content respectively. 1 kg weight of each sample was taken out for the experiment.

2.4. Speed of operation

The machine speed of operation was varied via pulleys at 30, 35, 40, 45, and 50 rpm respectively.

2.5. Determined parameter:

2.5.1. Dehulling Efficiency, E_C, (%)

This determines how efficient the machine dehulls the fed groundnut, it is expressed as:

$$E_c(\%) = \frac{M_i}{M_f} \times 100 \quad (1)$$

Where, E_C (%), is Dehulling Efficiency; M_i, is mass of groundnut before dehulling, kg and M_f, is mass of groundnut after dehulling, kg.

3. Results and discussion

3.1. Effect of Speed on Dehulling Efficiency

Figure 3 shows the effect of speed and moisture content on dehulling efficiency. It was observed that speed is inversely proportional to efficiency; increase in speed resulted to a reduced dehulling efficiency. Highest dehulling efficiency of 80%, 78%, 77%, 90% and 73% was recorded at the lowest speed (30 rpm) while the lowest efficiency of 57%, 49%, 53%, 52% and 46% was recorded at the highest speed (50 rpm) in all moisture content (1.4, 1.6, 1.8, 2.0 and 2.2%) respectively. Thus, lower operation speed gives best performance; indicating that roasted groundnut dehulling operation is a low speed operation. This conforms to the findings of [1] that low operational speed gives better results in roasted groundnut dehulling. Also the percentage of split roasted groundnut increased within the same moisture content with increase in operation speed (Figure 4).

3.2. Effect of Moisture Content on Dehulling Efficiency

It was observed (Figure 3) that the machine had the best efficiency of 90% at 2.0% moisture content (w.b) and 30 rpm speed which is a medium moisture. This conforms to [14] that reported a similar case after obtaining the highest dehulling efficiency (80%) at 12% moisture content (w.b) from a range of moisture contents. Hence, medium moisture content is best for roasted groundnut dehulling.

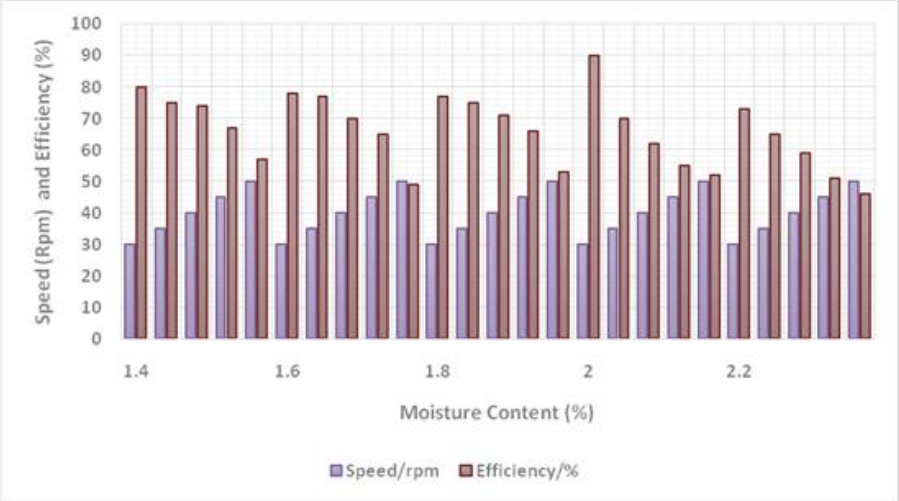

Figure 3 Effect of speed and moisture content on dehulling efficiency

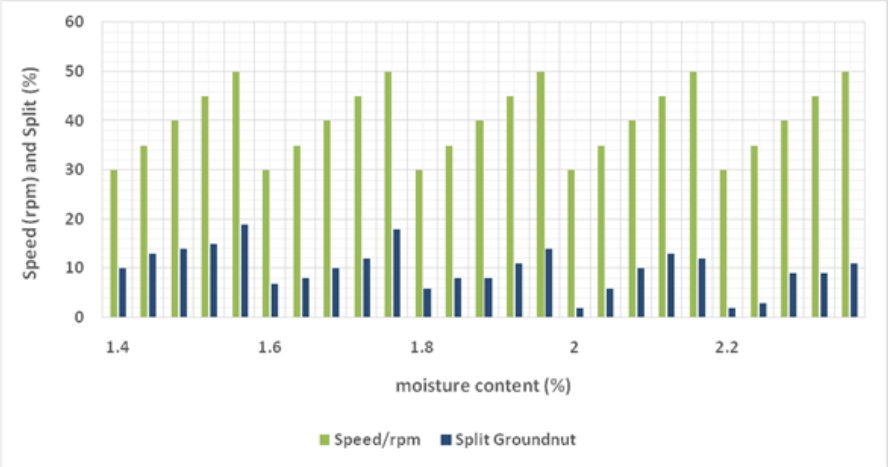

Figure 4 Effect of speed and moisture content on splitting of groundnut.

4. Conclusion

From the results of the experiments conducted, it can be concluded that mechanical dehulling of roasted groundnut is a low speed and medium moisture operation. The machine had the best dehulling efficiencies of 80%, 78%, 77%, 90% and 73% at the lowest speed (30 rpm) while the lowest efficiency of 57%, 49%, 53%, 52% and 46% was recorded at the highest speed (50 rpm) in all moisture content (1.4, 1.6, 1.8, 2.0 and 2.2%) respectively. The best performance efficiency of 90% was gotten at 30 rpm and moisture content of 2.0 % (w.b). Hence, an optimum operating condition was established for the machine.

Compliance with ethical standards

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Disclosure of conflict of interest

We, (Olubo, A.S; Stephen, J.T, Adeyinka, A and Opadotun, O.O) the authors of the article "Effects of some test parameters on dehulling efficiency of a roasted groundnut seed dehulling machine" wish to state that there are no conflicts of interest in this our research article.

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