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PERFORMANCE EVALUATION OF A BURR MILL FOR PROCESSING OF MAIZE GRITS

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ABSTRACT
This paper examines the performance of a burmil using dry and wet maize at variable moisture contents and operating speeds. The moisture contents of the dry maize were 10%, 12%, 14% and 16%. For wet experiment, the moisture contents were 22%, 25%, 30% and 35%. The operating speeds for both dry and wet experiments were 500, 550 and 600 rpm. The weight of samples were measured using an electronic weighing machine; the moisture content was taken with a moisture-meter and the milling time recorded using a stop watch. The results showed that milling efficiency decreased with increase in moisture at all operating speeds in the two experiments. Optimum performance was recorded at 22% moisture content for wet experiment and operating speed of 500 rpm at 74% milling efficiency. While the optimum performance for dry maize was at 10% moisture content and 550 and 600rpm operating speeds at 83% milling efficiency. The particle size distribution increased with increase in moisture content at all the operating speeds. The finest particle was observed at 10% and 22% for both dry and wet experiments respectively. A linear relationship was observed between the operating speed and the milling efficiency as well as the particle size distribution. It is concluded that a linear relationship therefore exists between the moisture content, operating speed, milling efficiency particle size distribution of maize grit. The results of the evaluation are therefore recommended for the use of farmers, fabricators and processing industries.

KEYWORDS: Burr mill, performance evaluation, maize processing, maize grit.

INTRODUCTION
Agricultural or food materials are products from the farm which are either consumables or raw materials for industries. Its processing is a post-harvest operation that adds value to agricultural products (Mijinyawa, et. al, 2007). Processing is a form of value addition. Its objective is to minimize the qualitative and quantitative deterioration of the materials after harvest. Food processing and preservation is a branch of manufacturing that transforms raw animals, vegetables or marine materials into consumable safe food products. (Ricardo, 2009).

Processing helps to improve the palatability, nutritive value and shelf –life of the agricultural produce. Food processing is traditionally a woman's work in Nigeria. Many women undertake food processing for income generation purposes within the confines of the family compound (Adekanye, 2007). Food processing is an integral part of agriculture as most produce must undergo one form of conversion or the other either for storage or breaking down into smaller, workable units as a food source or raw material. In the process of changing agricultural materials from one form to another with the use of fabricated processing machine, contacts do occur between the produce and the machines used. Particle size reduction or milling is a necessity for agro-materials to make them smaller before further processing or utilization.

The earliest records of food production in Africa show that indigenous crops have long been milled to produce coarse flour for cooking. Traditional crops such as yam, sorghum and millet have been ground for centuries either with a crude mortar and pestle fashioned from tree stump and branch or by using flat stones or rubbing stones (Lominda, 2015). Various types of mills are in widespread use in rural parts of the world in areas where no electricity grid is available. Diesel powered grain mills are limited to areas with access to fuel and spare parts.

(Jonsson and Dend, 1984). The stone mill or quern, either hand, animal or motor-driven is relatively unknown in Africa despite having given good service in many other countries. This machine operates on the same principle as plate mills but uses large stones instead of plates and is set with a vertical axis. The skills of dressing stones have not been acquired in areas where appropriate stones have not been easily available. However, there are isolated examples of stone mills in Africa that are well designed for using low-speed animal power. (Eastman, 1980).

Large scale mills are in operation in most Africa countries today. They mainly supply flour to larger cities and towns. These mills use fluted roller mills that operate to a higher technical standards than small-scale mills. They can remove bran and wheat germ, producing refined white flour mainly for bread making. Larger-scale roller mills are also used to mill maize into grits. (Brian and Alexandral, 2006).

Size reduction consists of breaking or cutting a solid crop to smaller pieces. Cutting mostly involves degree of impact and attrition (friction). Size reduction processes can be achieved by successive compaction and tension, as in a burr or plate mill. The basic mechanisms of size reduction are shear, impact, and attrition. Shear is exerted by cutting the crop using a sharp auger. When the cutting device is an auger, the augers geometry and the direction of the cut in relation to the materials being cut affects the configuration of the resulting ground materials, the cutting power needed, and the quality of the chips surface (Jafari, 2008). One of the bases of size reduction is crushing in which particles are crushed by compression and impact. Burr mill or plate mill consist of two plates one rotating plate and the second is stationary. It was reported by Fellows (2003) that using a hammer mill had the advantages of low maintenance over the other methods like crushing, shearing and roller mills. Tub grinders are small mobile hammer mills often designed as pull-behind units for agricultural use or mounted on tractor trailers for larger waste removal. Attrition is used primarily for grinding of toxic organic materials such as wood pulp and grits (Perry 2008).

Size reduction is also applicable in pulp making and paper industries. Ceramic segments are attached to a steel reinforce concrete core. Attrition between logs and these ceramics segments cause the grinding of wood and the production of the fiber particles. Based on the feeding systems. They can be chain grinder, pocket grinder, pressure grinder or thermo grinder

The reduction in size of agricultural products is brought about by mechanical means without change in chemical properties of the materials (Enrique, 2012). This improves the eating quality or suitability of foods for further processing and to increase the range of available products. Development of varieties of size reduction machines has resulted in the reduction or total removal of drudgery from processes which hitherto were tedious to accomplish. The size of agricultural products may be reduced in several ways. There are so many size reduction machines that have been designed and fabricated but few have been subjected to appropriate evaluation for agricultural and domestic uses. So there is the need to for appropriate evaluation of the bur mill so that suitable data can be available for the use of fabricators and processors of maize. Therefore, evaluation of the performance of a bur mill was carried out using maize at wet and dry moisture conditions.

MATERIALS AND METHODS

Evaluation Procedure

Wet Experiment

In wet experiment, maize of variable moisture contents (22%, 25%, 30% and 35%). 1kg of each sample at the different moisture content was weighed before milling at variable operating speeds varying of 500, 550 and 600 rpm for the evaluation. Each of these samples was milled at various operating speed to determine the effect of operating speed and moisture content on the milling efficiency of the machine. The output was weighed by the use of electronic weighing machine and the time used for each milling was recorded using a stop watch. The milling efficiency and throughput capacity were determined respectively using equations 1 and 2.

Dry Experiment

In dry experiment, the maize subjected to different moisture content varying from 10%, 12%, 14% and 16% for the evaluation. Each of these samples were milled at different speed of 500, 550 and 600 rpm to determine the effect of operating speed and moisture content on the milling efficiency of the machine. The output was weighed using the electronic weighing machine and the time taken to mill was recorded using stop watch. The milling efficiency and throughput capacity were determined respectively using same equations as applicable.

Efficiency, $E = \frac{Out\ put}{Input} \times 100$ 1

Throughput Capacity, $TC = \frac{Feed\ Input\ (Kg)}{Milling\ Time\ (S)}$ 2

RESULTS

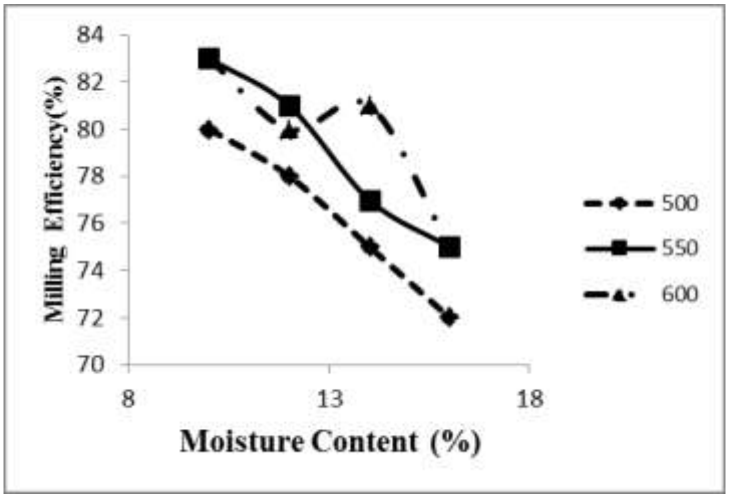

Fig.1: Effect of Moisture Content on the Milling Efficiency of Dry Maize at 500, 550 and 600rpm.

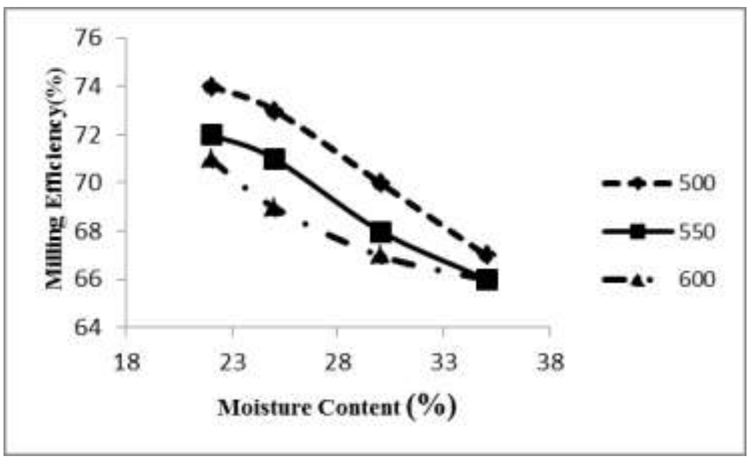

Fig.2: Effect of Moisture Content on the Milling Efficiency of Wet Maize at 500, 550 and 600 rpm.

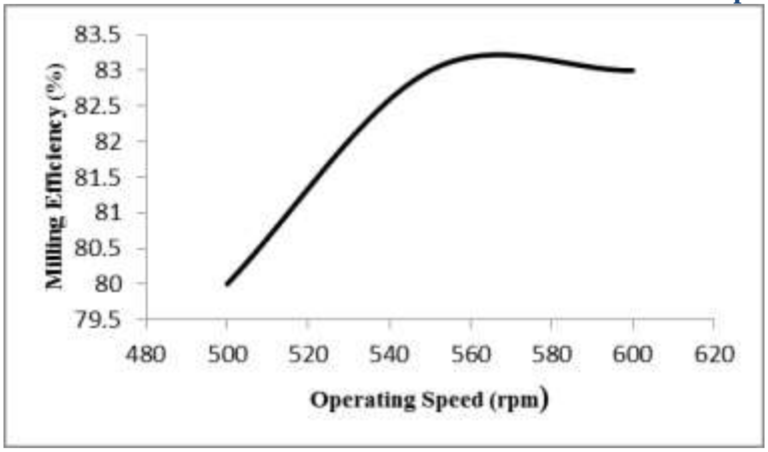

Fig.3: Effect of Operating Speed on the Milling Efficiency at Optimum Moisture Content of 10% for Dry Maize Experiment

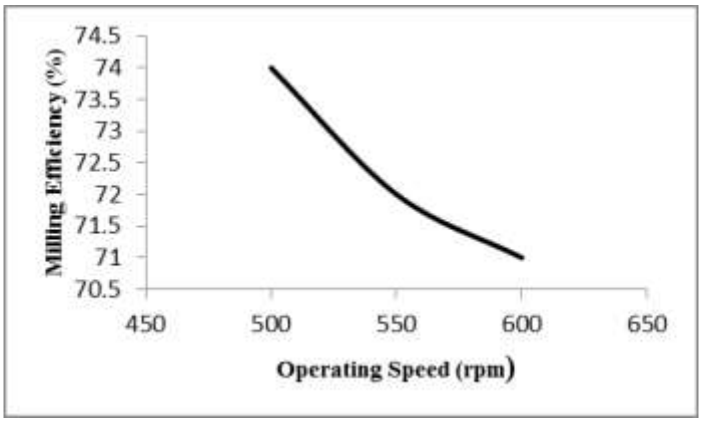

Fig.4: Effect of Operating Speed on the Milling Efficiency at Optimum Moisture Content of 22% for Wet Maize Experiment

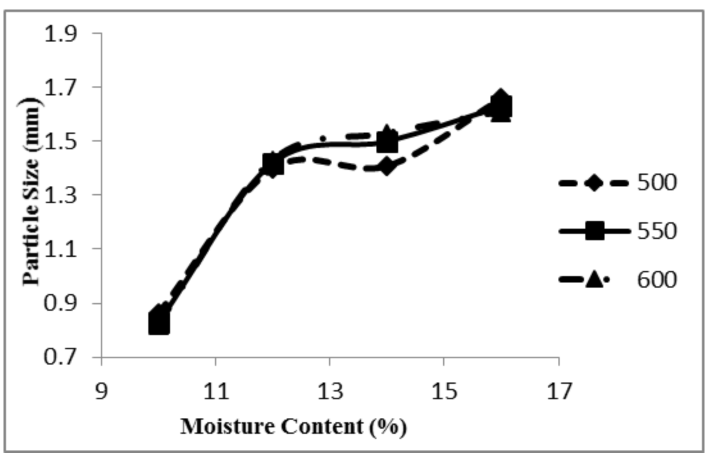

Fig.5: Effect of Moisture Content on the Particle Size Distribution of Dry Milled Maize Grits

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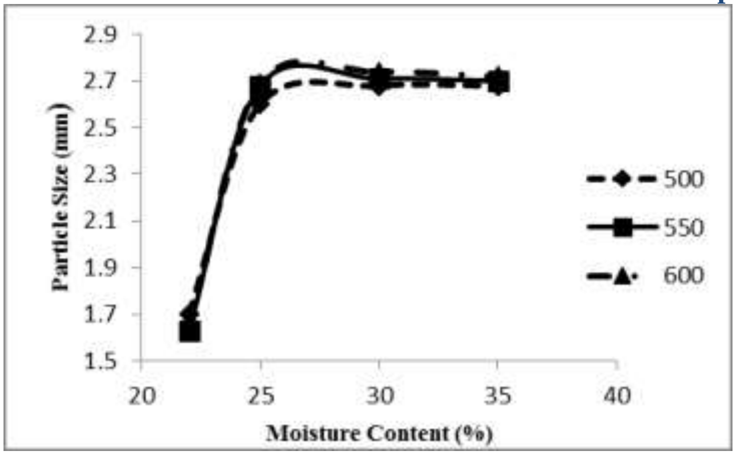

Fig.6: Effect of Moisture Content on the Particle Size Distribution of Wet Milled Maize Grits.

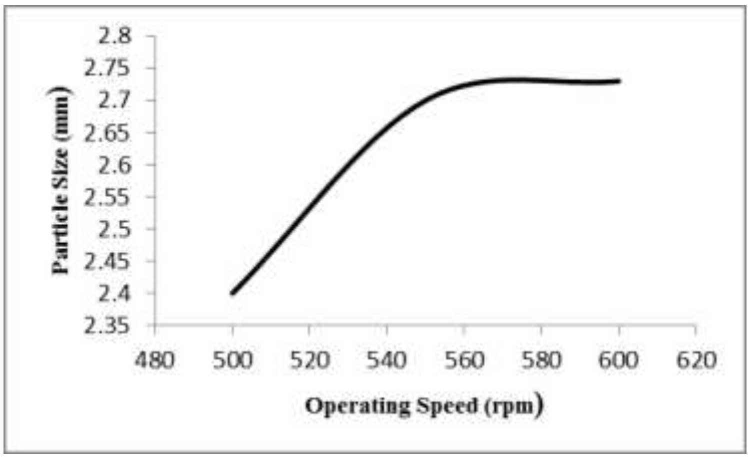

Fig.7: Effect of Operating Speed on the Particle Size Distribution of Wet Milled Maize Grits

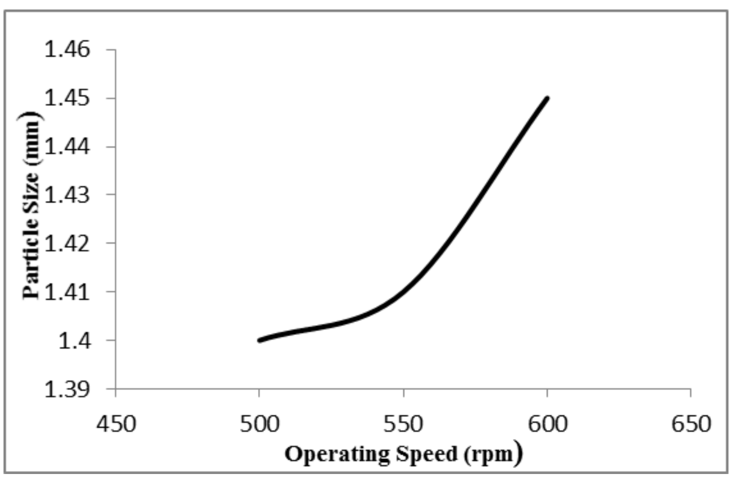

Fig.8: Effect Operating Speed on the Particle Size Distribution of Dry Milled Maize Grits

DISCUSSION

Effect of Moisture Content on Milling Efficiency

The relationship between moisture content and milling efficiency is represented in Fig. 1 and 2. It was observed that the milling efficiency decreased with increase in moisture content at all operating speeds (500,550 and 600 rpm) for milling both dry and wet maize. But the highest milling efficiency was recorded at both 550 rpm at the optimum moisture content of 10% for dry experiment while the highest milling efficiency was recorded at the operating speed of 500 rpm at the optimum moisture content 22% for wet experiment. A linear relationship as observed exist between moisture content and the milling efficiency of dry and wet experiment. This is in conformity with Feyisetan (2009) who reported that efficiency of a fabricated burmil depended on the moisture content of the food materials

Effect of Operating Speed on Milling Efficiency

Fig. 3 shows that milling efficiency increased with increase in operating speed at optimum moisture content 10% for dry experiment. It was also observed in fig 12 that the milling efficiency decreased with increase in operating speed at the optimum moisture content 22% in wet experiment and these are described as a linear relationship.

Effect of operating speed on particle size distribution

As presented in Fig.7, a linear relationship exists between particle size of the dry maize grit and the operating speed.it was observed that the particle size decreased with increase in operating speed. While Fig. 5 and Fig. 6 show a linear relationship between moisture content and particle size that the particle size of the wet maize grit increased with increase in moisture content at all operating speeds for both dry and wet experiment.

Effect of Moisture Content on the Particle Size Distribution

As presented in Figure 6, the particle size initially increase with increase in moisture content but later remains constant at particle size of 2.7 mm at all the operating speeds in the wet experiment. While in the dry experiment, the particle size increased with increase in moisture content at all the operating speed with little variations in values recorded. It was observed from the two experiments that the particle size seized to increase with increase in moisture content at 22% moisture content.

CONCLUSION AND RECOMMENDATION

From the evaluation, it can be inferred that the moisture content and operating speed of the machine and moisture content of crops affects the size reduction operation of maize.

It can be concluded that milling efficiency decreases with increase moisture content at all the operating speeds for both dry and wet milling of maize at optimum moisture content of 10% for dry maize and 22% for wet maize. There is a linear relationship between the operating speed and the milling efficiency of both dry and wet maize. There is a linear relationship between particle size distribution and the operating speeds. The particle size decreases with increase in operating speed as well as the moisture content at all the operating speeds for both wet and dry milling for maize.

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