

OPTIMIZATION OF PARTICLE SIZE REDUCTION PROCESS OF A LOCAL MAIZE VARIETY USING A LABORATORY HAMMER MILL

O.C. Chukwuezie, N.R. Nwakuba, S.N. Asoegwu

*Department of Agricultural and Bio-environmental Engineering,
Imo State Polytechnic, Umuagwo, Nigeria.*

*Department of Agricultural and Bioresources Engineering,
Michael Okpara University of Agriculture, Umudike, Nigeria.*

*Department of Agricultural and Bioresources Engineering,
Federal University of Technology, Owerri, Nigeria.*

Abstract

Optimization of size reduction process of a local maize variety (*Okaocha*) using a laboratory hammer mill was studied to minimize the process energy requirement. The specific objective was to develop empirical models relating the design parameters and the final particle size as well as the energy requirement for size reduction operation. The experiment was designed and analyzed using the Central Composite Design (CCD) and Response Surface Methodology (RSM). Results obtained show that the condition for optimal particle size reduction was obtained at 91.5% overall desirability index were: grain moisture content of 15% wet basis, shaft speed of 1500rpm, number of hammers of 16, feed rate of 347g/min and sieve size of 3mm. Grinding from an initial size of 5.47mm to finest particle size of 0.018mm; shaft speed, number of hammers and feed rate contributed 49%, 25% and 12% to particle size reduction and 51%, 29% and 13% to energy consumption respectively, whereas sieve size and moisture content caused 11% and 19%; 15% and 26% increase in particle size and energy drop respectively. Quadratic models developed using the experimental values were adequately predicted the particle size reduction and energy requirement at R^2 -values of 0.9481 and 0.8757 respectively. The study reveals that shaft speed and number of hammers played dominant roles in the grinding operation. The interaction effects essentially increased disintegration of the grain samples and air stream flow across sieve size which possibly made particle exit easier.

Keywords: Particle size reduction, optimization, hammer mill, response surface, maize.

1. INTRODUCTION

Grinding of maize (*Zea mays* L.) in developing countries is mostly done using hammer mill (Hadiet *al.*, 2017). Hammer mill also known as cereal miller consists of high speed free swinging hammers that reduces grains by the

principle of impact (Onwualuet *al.*, 2006). With the combination of impact from hammer and on the wall casing, as well as collision amongst particles, the feed disintegrate and drops through a perforated screen. Although, the machine