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# THE INFLUENCE OF SPEED COMPRESSION ON THE MAIZE GRINDING PROCESS

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***Abstract:*** *Due to a high-energy consumption per unit in the milling industry, it is necessary to make a rigorous study on the grinding process and implicit on the methods for achieving the grist. The main goal of researchers in recent decades has been finding ways to reduce this energy consumption. In order to reduce energy consumption studies were made researches to highlight the influence of external load application rate on energy consumption in the grinding process. For this purpose, experimental research has been conducted on individual maize kernels at three different speeds 25 mm min$^{-1}$, 50 mm min$^{-1}$and 100 mm min$^{-1}$, maintaining constant moisture value.*

***Key words:*** *grinding process, individual corn kernels, moisture, compression.*

## 1. Introduction

Maize (Zea mays L.) is one of the most versatile cereal crops of the world. Also referred as corn, it is an important cereal crop, serving as staple to large population of Africa, Asia and North and South America [3]. The importance of corn processing industries is increasing. Recent concepts in corn marketing emphasise the identification of the specific, rigorous quality needs of individual users, and there is considerable interest in grain quality as an end-use value [1]. Information on physical properties of maize, like other agricultural materials, is necessary to design equipment for grading, handling, processing and storage etc. [3].

The behaviour of the corn kernel during compressive loading is one of its textual properties. The processing of corn for food and feed requires various types of mechanical treatment that depend on external forces [1].

The study of the behaviour of the non-homogeneous organic structure of corn kernels under compression loading offers a basis for general conclusions regarding how this type of change might be achieved. [1– 4].

Because compression behaviour is important in corn processing, studies that measure such behaviour over a different compression speeds are desirable.

The energy consumption from the grinding process is useful only partially; the rest of it, it is lost through the production of elastic and plastic deformations, by rubbing the material pieces between them and the active organs of the machine; or into internal mechanical

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transformations of the equipment. In order to achieve low energy consumption during the grinding process, it must be taken into account the establishment of a strictly particle size of the grinding process, and to use an appropriate choice of functional and technological scheme of the machine, which depends on the physical and mechanical properties of the cereals [8].

## 2. Materials and method

The experimental research were carried out on individual winter maize kernels, at 12% moisture content, pursuing energy consumption, the loading force and the kernel deformation [6,8], during the maize grain compression. Individual maize kernels are compressed with a constant speed of 25 mm min$^{-1}$, 50 mm min$^{-1}$ and 100 mm min$^{-1}$, until a constant distance of 0,5 mm between the two parallel plates was achieved. For each compression speed were selected 20 maize kernels and for data analysis and interpretation of experimental research were used the average of the 20 determinations.

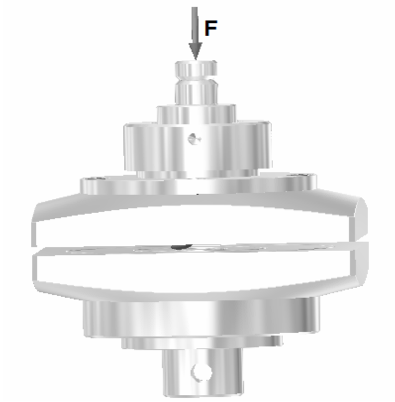


Fig.1. *Uniaxial compression of wheat grain between two parallel plates* [5],[8]

Measurements of grain resistance characteristics were carried out on a universal testing machine ZWICK /ROELL 005. The measurement accuracy was ±0.001 N in force of 0.001 mm deformation. Changes in the loading force in relation to kernel deformation and the energy consumption were recorded with the testing machine software "Test Expert"[7], [8].

All of the test kernels were checked for stress cracks and before loading, the thickness and length of each kernel was determined with a digital caliper. The individual kernels were put in to the middle of the bottom plate. In mechanical properties test, each kernel, was loaded until rupture occurred and the resultant load-deformation behavior and the work were recorded.

## 3. Results and discussions

To highlight the influence of speed compression on the maize grinding process, there were carried out processing data of experimental research, that were obtained from individual maize kernels crushed with a constant speed of 25 mm min$^{-1}$, 50 mm min$^{-1}$ and 100 mm min$^{-1}$ between two parallel flat plates.

There were compared values obtained from all three different test speeds, aiming the development of crushing resistance forces, the kernel deformation and the energy consumption, registered during the compression process.

The stress-strain uniaxial compression test shows the response of biomaterials to an externally applied force that deforms the body of the material, causing changes in dimension, shape, or volume. This test provides important information about elastic and plastic behavior. Stress is the external force upon the unit specimen cross-sectional area, $A_o$ ($m^2$), the unit is N m$^{-2}$. An important aspect of this is not necessarily the quantity of force but its application on the unit of cross-section area. For this reason, all specimens have regular shape such as that of a cylinder or a cube [1].

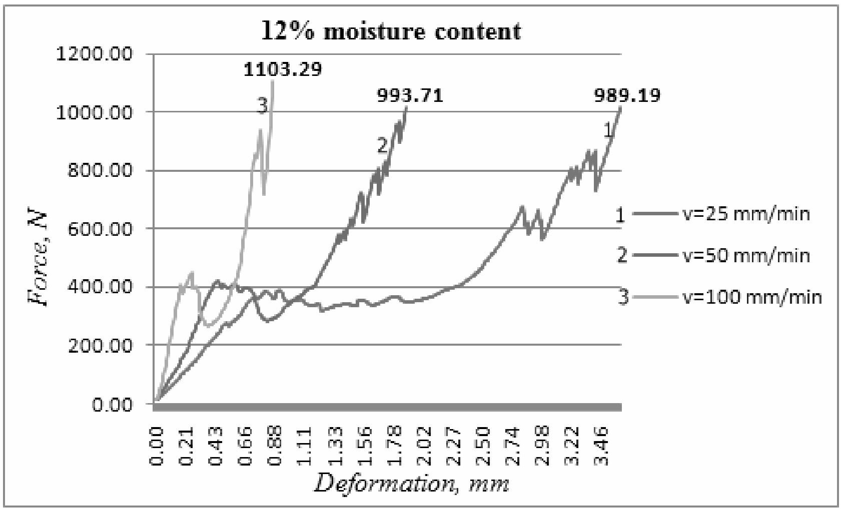


Fig.2. *Crushing force evolution of maize grains with 12% humidity, in relation with crushing speed.*

By analyzing the graphic shown in Figure 2, it was found that the development of crushing forces resistance, for all three test speeds are similar. In all the cases, the maximum crushing force is about between 989 and 1103 N.

For all test speeds, the characteristic area of elastic deformation is not very smaller. The appropriate force of elasticity limit for 25 mmmin$^{-1}$ is aproximatly 300 N with a kernel deformation of 0,5 mm and the greater elastic limit is reach at speed of 100 mmmin$^{-1}$ with 410 N and a kernel deformation of 0,43 mm.

As test speed increases, the elastic properties are higher, and the elastic plastic oscilations are shorter.

From the point of view of maize grains deformation, the highest value of 3.5 mm grain deformation is achieved at a test speed of 25 mmmin$^{-1}$. It can be noticed that, the lower the test speed is, the grains deformation increases.

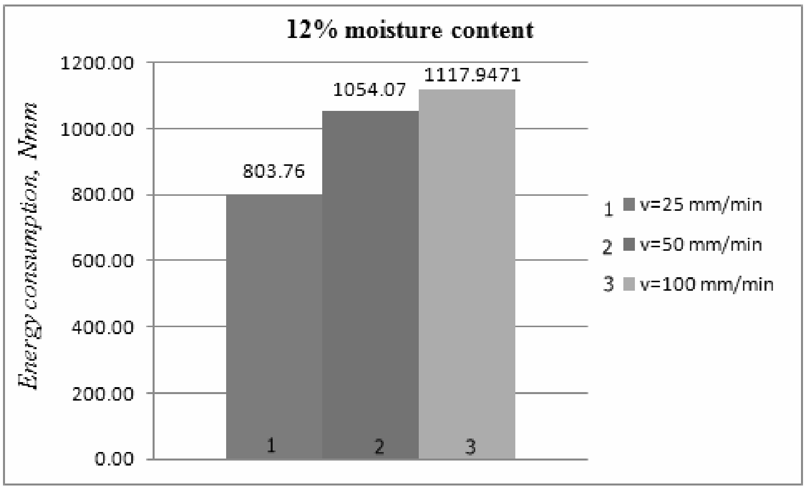


Fig. 2. *Energy consumption evolution on grinding process at three different test speeds.*

In addition, it can be notice that, the higher is the crushing speed, the greater is the force needed for crushing the maize kernel and the kernel deformation is smaller.

The energy values, consumed during the grinding crushing for the content of all three test speeds, are shown in figure 3. The maximum value of energy consumption is recorded for 100 $mmmin^{-1}$ maize compression speed.

Following the evolution of the values of energy consumption depending on the compression test speeds, it can be noticed that, with the increasing of compression speed, is increasing the energy consumption of the crushing process.

## 4. Conclusions

The behaviour of the corn kernel during compressive loading is one of its textual properties.

The stress-strain uniaxial compression test shows the response of biomaterials to an externally applied force that deforms the body of the material, causing changes in dimension, shape, or volume.

The higher is the crushing speed, the greater is the force needed for crushing the maize kernel and the kernel deformation is smaller.

With the increasing of compression speed, is increasing the energy consumption of the crushing process.

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