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ASSESSING THE CONTACT DURATION AND VELOCITY FOR POTATO TUBERS IN CORRELATION WITH THE IMPACT ENERGY

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Abstract: *This paper is focused on using a computer controlled pendulum to asses the potato impact in harvesting and handling operations. The computer controlled pendulum method is an adequate tool for studying the influence of three impact energies to contact duration and contact velocity, during impact between the pendulum impact body and the potato tubers from Dacia variety.*

Key words: *potato, impact, pendulum, energy, velocity, contact duration.*

1. Introduction

Vegetables and fruit are subject to different stress levels both during harvest and during subsequent post-harvest processing. This stress cause damage to the produce, compromising its preservability; lowering the consumption quality and bringing considerable economic loss. Mechanical forces are among the most important causes of fruits and vegetables bruising in the world. According to R. Peters, 42% of potatoes are damaged on harvesting, and 54% after grading [4,6]. The potato transport raises the incidence of bruised potatoes with 10%. As a consequence almost two thirds of the potatoes purchased by the consumer have internal or external damage [4,6]. The losses caused by potato damage are estimated at £200 per hectare by the The British Potato Marketing Board [4,6]. If one should consider other fruits and vegetables with low texture resistance the quality losses problems are much bigger. It therefore becomes important, above all, to measure the intensity of the impacts to the produce during harvest and post-harvest and subsequently to correlate this with the probability of damage to the produce itself.The Potato is one of the most important crop in the world. Some reports states that "Potato is the world's fourth important crop after wheat, rice and maize because of its great yield potential and high nutritive value. Economic losses due to potato bruising are significant.

The potato industry needed to know not only how to improve harvesting and handling equipment and operations, but also in electronic format, identical with the printed copies.

2. Material and method

The impacts occur primarily when the tubers strike hard surfaces or each other while being conveyed, or in dropping

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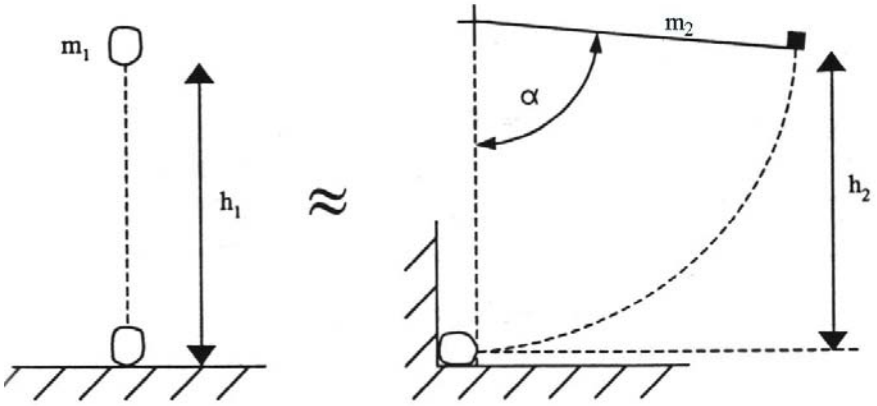
from one conveyor to another. Current technique allows the utilization of some methods that will reduce mechanical impacts by reproducing in the laboratory he process which harm the tubers under mechanical loadings produced by external forces. To simulate a real impact with a blunt tubers have been developed several methods of testing [1], [2]. Choosing a particular test procedure must be done very carefully so that similar test conditions to actual conditions impact the transport and handling processes harvest potato tubers.

In figure 1 is presented the testing of potato tubers using a pendulum device, assuming that there is no difference between the situation when a potato tuber mass m_1 falls free from the height h_1 on a plan and rigid body and the situation with the same tuber hit by a pendulum with an effective mass m_2. The effective mass m_2 of impact is equal to the mass of the tuber m_1, and the falling height of the pendulum h_2 mass is equal to the height of the fall of the tuber h_1.



Schematic representation for the impact between potato and surface:
a – *potato free falling* ; b-*the impact scheme*

The impact energy of the pendulum is determined by the initial angle of the arm, the arm pendulum mass and body weight impact and air resistance. In the calculus the low resistance opposed by the air can be ignored. The pendulum arm *4* is a cylindrical metal tube with a length of 600 mm fixed on the top at the mainframe 1 directly on a rotary encoder ax 7 which registers the rotation angle of the pendulum arm. The acceleration after impact and deceleration during the impact is measured by an accelerometer *2* fixed on the arm of the pendulum at the backside of the impact body 3 as in the figure 2. The quartz shear ICP® accelerometer used for general purpose.

An electromagnetic system 6 fixes the pendulum arm in a position necessary to administer the desired potential impact energy [1], [2]. At the other end of the pendulum arm is fixed a non spherical impact body 2.

The electrical signals produced by the accelerometer and encoder when the pendulum arm is released by the electromagnetic system, are isolated and amplified by a data acquisition system.

Another element of the pendulum is the sample holding system *8*, designed to fix the potato sample *9* and avoid supplementary loadings.

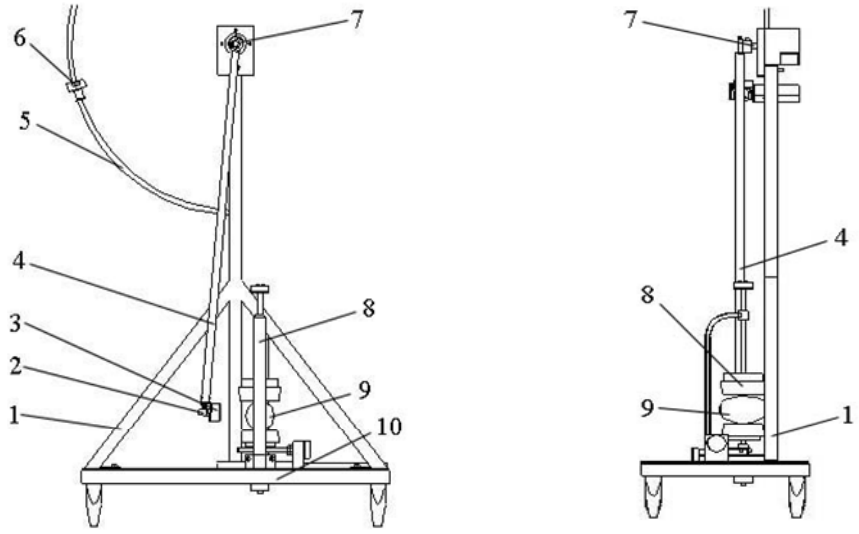


Fig. 2. *The computer controled pendulum scheme*

a *– front view*; ***b*** *– side view* :

1– mainframe; 2 – accelerometer; 3 – impact body; 4 – pendulum arm; 5 – circular holder; 6 – electromagnetic device; 7 – rotary encoder; 8 – sample holding system; 9 – sample; 10 – mainframe table

Each tuber was subjected to an impact in four different positions on the circumference indicated by *a, b, c, d* as shown in figure 3, resulting four situations of impact for each sample.

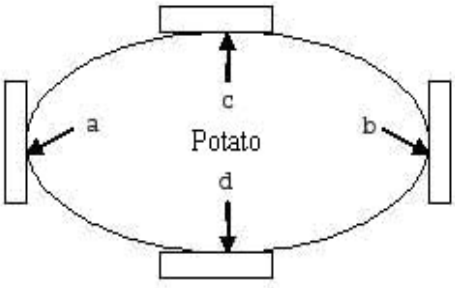


Fig.3. *The impact positions*

Tubers from a specific variety were fixed in the sample holding system and the pendulum arm is directed to impact the tuber in a well defined area of its impact, as presented in figure 3.

In order to analyze the signal generated by the accelerometer and transform it in an impact force, a Labview application was used. Labview is a graphical programming language which helps achieve a block diagram that can be further executable. The Labview programs are virtual instruments composed of a frontal panel and a block diagram.

The frontal panel specifies the entrances and the exits and creates the part of interactive operations. The figure 3 shows the way of transforming the acceleration signal in force using Labview.

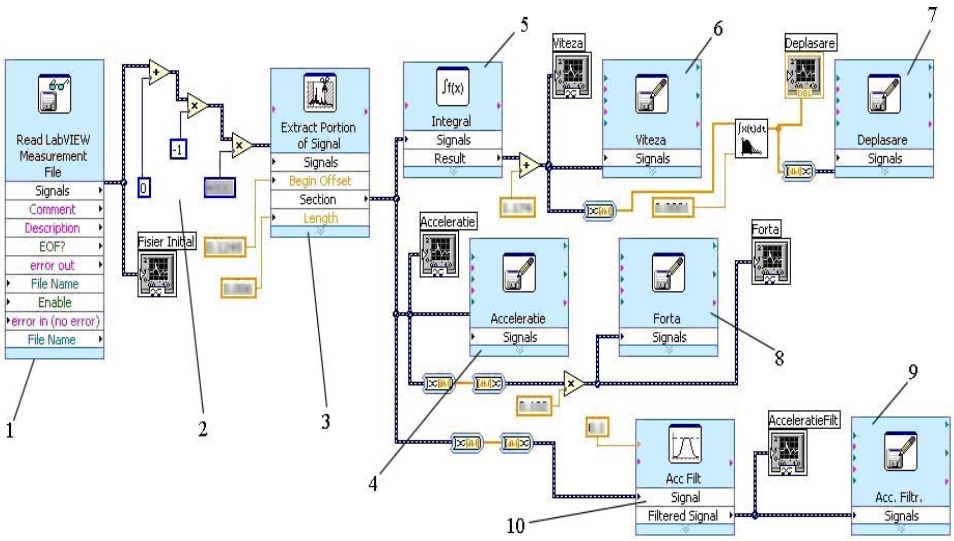


Fig. 3. *Sequence from the Labview block*
1– impact folder; 2 – recording block ; 3– block for signal extract; 4 – block for acceleration signals; 5– block for integration ; 6 – block for velocity signals; 7 – block for deformations signal; 8 – block for force display; 9,10 – blocks for signal filtrate.

3. Results and discussions

The impact acceleration determination is very important because on its basis the impact velocity, the impact force, the absorbed energy etc. can be determined. When the impact body hits the potato an Ascii file (impact folder) is generated. This file is analyzed by the Labview application and the primary impact accelerations are processed by the block presented in figure *3* and transformed in impact forces. The graph obtained with Labview for the first impact is presented in figure 4.

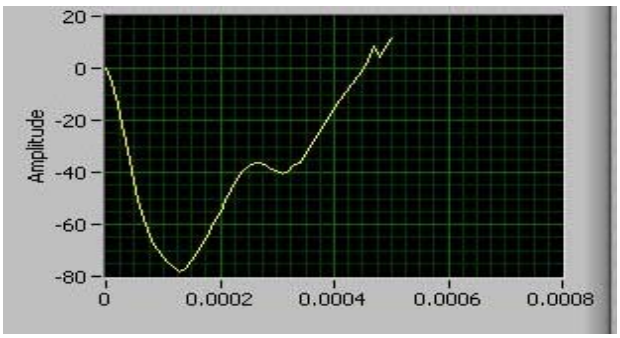


Fig. 4. *The impact forces variation versus time*

A Mathlab application is used also to transform the Ascii file in velocity - time curves. In figure 7 are presented the velocity curves versus time for three different initial impact energies: $E_1 = 0{,}072$

J, E_2 = 0,325 J, E_3 = 516 J obtained with the Mathlab application.

When the potato sample is exposed to impact from the specified energies, tubers suffers a compression followed by a rebound phenomenon that occurs over a period of time called impact duration.

This duration represents the time of the contact between the sample and the hard impact body during colision. Further several trends of the impact collision can be observed.

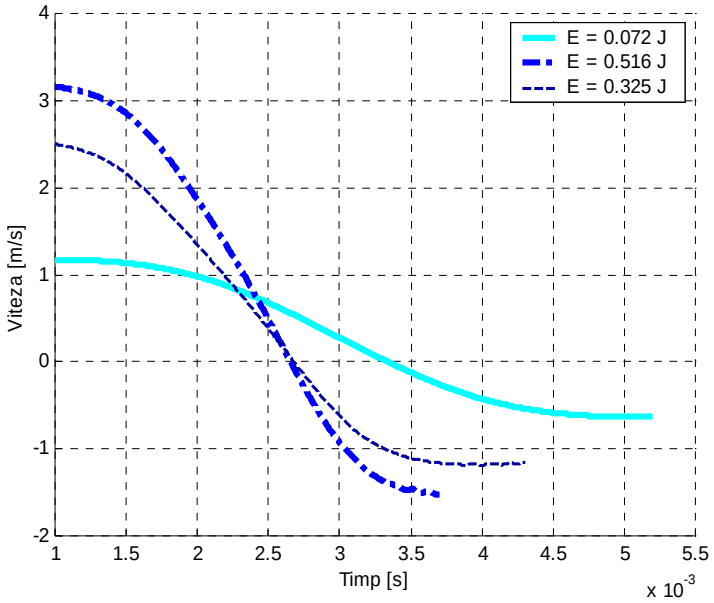


Fig. 5. *The impact versus impact velocity for three different initial impact energies* .

In the chart from figure 5 can be observed the duration and impact velocity according to the initial impact energies. When the initial energy of impact increases (from 0.072 to 0.325 J) the impact duration decreases with 0.93 ms (from 5.25 ms to 4.35 ms) and the impact velocity rises with1.25 m/s. (from 1.25 m/s to 2.5 m/s). Further, increasing the initial energy of the impact to a value of 0.516 M, the impact time value reaches the value of 3.75 ms and the impact velocity reaches the value of 3.25.

4. Conclusions and future work

The high tech measurement systems are very useful for testing the impact between potatoes and harmful surfaces from the handling chain. The computer controlled pendulum proved to be a very useful tool to impact tubers to short time mechanical loadings to provide the impact velocity and duration precisely and reproducibly. As the device is adjustable to a wide range of impact situations, it can be acquired in order to asses the impact parameters.

The advantage of using the pendulum pendulum device is the accuracy and reproducibility in impact studying. The design of the pendulum design pendulum and the arm's length allows the simulating of impacts from falling heights greater than 500 mm, cases often encountered in practice. Also the pendulum arm mass arm was chosen to be close to that of a medium sized tuber.

The computer and the Labview application allows instant view of the impact parameters. Finally, the obtained curves can be analyzed. The impact durations and velocity have different levels according to the impact energy used. The experimental results showed that there are significant differences in the response of the impact from tubers of the same variety with different fertilization.

From the analysis of the variation curves of the impact parameters experimentally obtained can be established that for all varieties tested mean values of accelerations, forces, velocities, strains and energy absorbed during impacts increase with increasing initial energy impact.

The results shows that increasing the initial energy of impact, causes a decrease in contact time between sample and pendulum but also an increase in the speed of impact. These results are useful for specialists in the field in order to analyze the behavior of Dacia variety to mechanical impact and their effects.

5. References

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