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IMPROVING QUALITY CONSUMPTION OF FRUIT AND VEGETABLES REDUCING THE MECHANICAL IMPACTS

D.M. DĂNILĂ[1] L. GACEU[1]

Abstract: *The paper presents a method for minimizing the impact loadings of fruit and vegetables in the harvesting - storage flow by choosing the proper impact height. Less impacts amount in fruit and vegetables means less bruises and consequently improved consumption quality. The impacts results are recorded with an electronic potato and processed further in order to obtain useful information.*

Key words: *fruits, vegetables, impact, electronic, potato.*

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 [5]. 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 [5]. The losses caused by potato damage are estimated at £200 per hectare by the The British Potato Marketing Board [5]. 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. For this purpose the researchers in potato mechanical damage fields use impact sensor for assessing mechanical impacts. These sensors are part of a potato shaped element named electronic potato [1].

2. Working Method

In order to simulate the impact loading that occurs in potato harvesting, transporting and handling lines, researchers in the field of potato bruising resistance field use digital potato devices. At its simplest, the digital potato acts as a food dummy which quickly locates many, damage-causing parts in all types of potato handling machinery (including washers) [2]. At its most sophisticated, the digital potato can focus on very specific levels of damage-causing problems; record and

[1] Dept. of Engineering and Management in Tourism, *Transilvania* University of Braşov.

download informationto a PC information about problems in different machines or the same machines at different times; and change its sensitivity to suit different potato varieties or even other fruits and vegetables [1-4]. The 'potato' element contains tri-axial shock sensors, a radio transmitter and a battery. When the potato receives a shock of sufficient strength to register an electronic signal, this signal is transmitted to the 'Receiver' [4]. The signal is heard in the headphones plugged in to the receiver, it registers on the receiver's display as it occurs and it is logged in the receiver's memory. The digital potato registers shocks within a specific range. This range encompasses the levels of shock, which will bruise potato but also includes very low levels of shock that will bruise more sensitive products [4].

The digital potato is an instrument, which can give valuable service at all, times during production. Bruising problems caused by poor machine maintenance or incorrect settings can be detected at any time. Machine settings are often changed during production, but the effects on bruising may not be realized. The digital potato provides a quick check for harvester settings. Different varieties or the same variety at different temperatures can bruise at different shock levels. In conjunction with bruise testing the digital potato can establish the parameters for bruise-free working in specific conditions.

Briefly, when the digital potato 1 (Figure 1) hits a surface 2 sends a signal to a receiver 3 which records the information [1], [2].

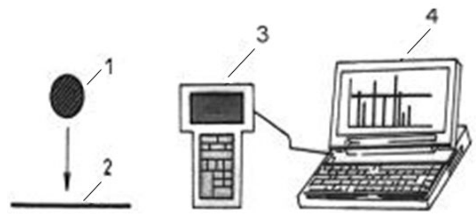

Fig. 1. *Impact recording*

After all the data are downloaded from receiver into computer 4 the dates are displayed here as tables and graphics.

3. Measuring the Influence of Height and Impact Surface in Potato Response

A significant amount of potato bruising injury can occur during truck unloading. In this case the mechanical damages to tubers are produced especially by the impact between the falling potato and the floor of the truck bin (at the beginning of unloading) and the impact between falling potatoes and piled potatoes. The degree of mechanical injury by dropping tubers depends on the height of fall of the tubers as well as on the bin surface characteristics. For minimizing the injuries in this cases several measure has to be taken. The first measure is lowering the boom as far as possible. For bulk trucks there are special devices available using sensors which are attached to the harvester unloading arm with the purpose of maintaining the potato falling distance under the value of 500 mm. Also cushioned surfaces used in the truck bed can reduce the distance for the first potatoes that drop into the truck. For limiting the potato falling velocity, a rubber-

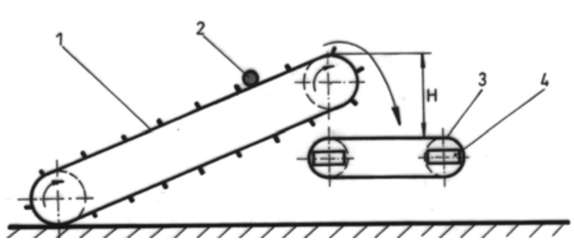

Fig. 2. *Modification of impact surface height*

fingered shoot attached directly to the boom can be successfully used.

Figure 2 presents the lab simulation of the real impact conditions between real potato and impact surfaces from harvester as well as the impact height *H*. A digital potato 2 is put on the moving conveyer belt 1 and dropped on two different surfaces 3. The testing impact surfaces are commonly used in potato harvesting.

The distance *H* between the top of the conveyer belt and impact surface can be modified by moving the forklift arms 4 that sustain it. In Figure 3 the impact surface called C profile is presented. The surface elements are: C profile rubber element notated with 1, steel hearth fixing notated with 2, and support band notated with 3.

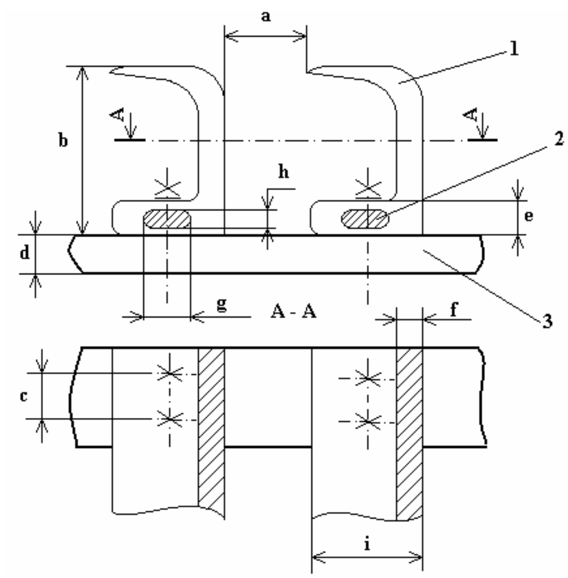

Fig. 3. *The C profile surface*

In Figure 4 another impact surface called sieve band is presented. This type of surface is often used in the potato handling chain.

This surface is composed of: the sieve bar element 1, steel heart 2, support band 3 and rivet 4.

4. Procedure for Impacts Analysis

When the potato hits the surfaces, a condenser placed inside the potato absorbs the energy of impact. Due to constructive defects, the entire energy is not always discharged at once. So there were different delays between several shocks. In the dynamic situation, when the delay between two peaks is less than 0.4 s shocks are added. When the delay between two peaks is more than 0.4 s the shocks are considered to be different. After the data impacts data are downloaded from the receiver into computer, then there are exported by the PTR200 program as text files. The text files are converted into Excel files. The impact forces values are calculated by Excel with Equation 1 [8]:

$$F = e^{\frac{\ln(x)+7.8877}{2.048}}, \tag{1}$$

where F is the impact force and x the maximum impact value showed by receiver. Statistical interpretation using the *T*-test.

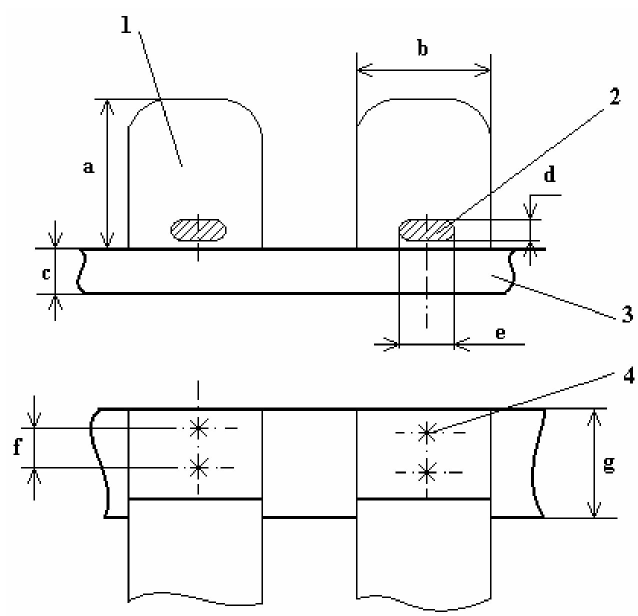

Fig. 4. *The Sieve band surface*

The number of calculated forces is different from run to run. This is the reason for choosing the *T*-test in interpretation of the data:

$$t = \frac{|x_A - x_B|}{\sqrt{\frac{s^2}{n_A} + \frac{s^2}{n_B}}}, \quad (2)$$

$$s^2 = \frac{(n_A - 1)s_A^{\,2} + (n_B - 1)s_B^{\,2}}{n_A + n_B - 2}, \quad (3)$$

where: n_A - number of forces for the first series; n_B - number of forces for the second series; s_A -standard deviation for the first series; s_B - standard deviation for the second series, t - distribution; s^2 - population variances [6], [7].

The *T* test procedure compares two series of calculated forces. If the t-value is higher than $t\alpha$ (provided by the table of t-distribution), the differences between the series are considered to be significant. The t-value was calculated with the formulas (2) and (3) [6], [9].

5. Obtained Results

The graphic from Figure 5 represents the compared means of impact forces resulted from impact between the digital potato and the testing materials presented in Figures 3 and 4.

Information from the graphic shows that in all cases the impact force recorded by the digital potato is lower for material C profile. This means that this material is more recommended in order to absorb the impact shock. Also the variation between impact force and transporter inclination is non linear for both materials.

6. Conclusions

The digital potato is a very useful tool in establishing the optimal heighs for potato dropping in order to reduce the impact forces. Small impact forces means less

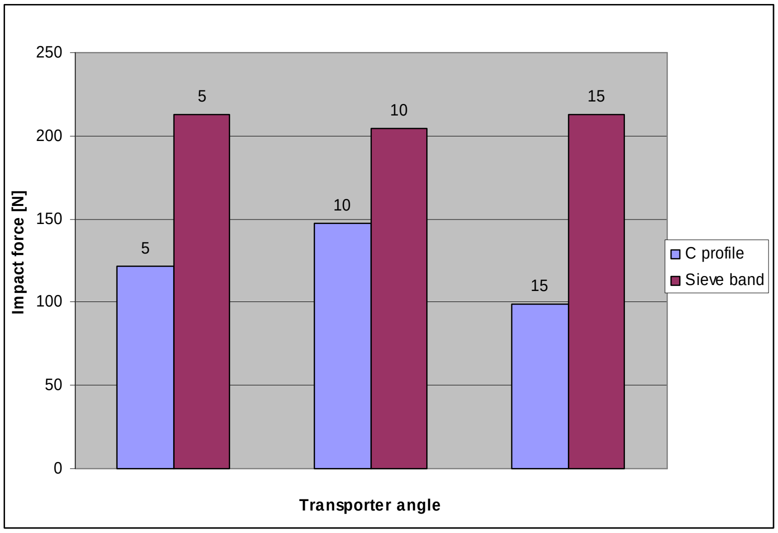

Fig. 5. *The impact force versus transporter angle*

mechanical damage produced by excessive drops. The bruising that occurs when tubers are dropped, is dependent upon several factors. One of these factors is the height of the drop which affects bruising, with greater damage when occurring at greater heights. Wood or metal surfaces do not absorb impact energy, while cushioned or padded surfaces can absorb some of the energy and reduce bruising severity [7].

For example, during the potato harvesting, the drop to the side elevator is one of the most serious injury points on the harvester, increasing the damage by 6 per cent or more. The final point of tuber injury during harvesting is dropping into the truck [7]. High quality potatoes sell first in any market situation.

Poor quality potatoes stack up on the grocer's shelf, reducing sales. Healthy potatoes have an increased benefit for environment and people [3]. The digital potato is an example of such high tech devices and its utility is demonstrated in this paper. This device has an important role in obtaining quality potatoes for market [3].

References

1. Dănilă, D.M.: *Instruments and Methods for Assessing the Impact behavior of Fruit and Vegetables*. In: Bulletin of the *Transilvania* University of Braşov (2005) Vol. 12 (47), New Series, p. 143-148.
2. Dănilă, D.M., Gaceu, L.: *The Management of the Potato Harvesting and Handling Chain for Minimizing the Economic Losses Due to Impact Loadings*. In: Abstracts of the 4th International Conference Aspects and Visions of Applied Economics and Informatics, Debrecen, Hungary 2009, p. 38-44.
3. Dănilă, D.M., Gaceu, L., Daniel, O., et al.: *Management of the Potato Crops for Minimizing Environmental and Human Health Impacts*. In: Environmental Engineering and Management Journal **9** (2010) No. 12, p. 1685-1691.
4. Lishman, M.: *The Digital Potato - PTR200 - Instruction Manual*. U.K., Ltd. Unit 2B Roman Bank, Bourne,

Links PE10 9LA, 2000.

5. Peters, R.: *Damage of Potato Tubers a Review*. In: Potato Research **39** (1996), p. 479-484.
6. Subhash, C.P., Kenneth M.: *Applied Statistics for Food and Agricultural Scientist*. Boston. G.K. Hall Medical Publishers, 1980.
7. Thornton, M., Bohl, W.: *Preventing Potato Bruise Damage*. Idaho. Idaho University, 1998.
8. Van Canneyt, T.: *Personal Communication*, 2001.
9. Walpole, R.E.: *Elementary Statistical Concepts*. New York. Macmillan Publishing Co., Inc., 1976.