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AN INFLUENCE OF SELECTED FEATURES OF MELROSE VARIETY APPLES ON BRUISE THRESHOLD

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Summary. In the article an influence of parameters such as: moisture content, water potential, firmness on bruise threshold of Melrose variety apples during four-week period studies was determined. The bruise threshold is defined as a drop height, at which bruise appears at a specific mass, shape and impact surface. To establish the bruise threshold twofold impact was used for drops at height range from 4 to 22 mm. To carry out the impact research, pendulum device was used with an apple as an impactor.

Key words: bruise threshold, apple, impact, moisture content, water potential, firmness.

INTRODUCTION

The damage developed as a result of mutual fruit impacts or their contact with machine and device elements occur in almost all production phases. On account of damage character and frequency appearance they can be divided into: abrasions, cuts, bruises occurred as a result of impacts [Knee & Miller, 2002; Dobrzański *et al*., 2006; Van Zeebrock *et al*., 2007].

Two first damage kinds are easy to eliminate and appear rarely. To minimise the occurrence of abrasion and cuts it is required to exchange sharp-edged machine construction and device elements having direct contact with plant material and follow the recommended harvest technology.

The most important damage group is this developed as a result of dynamic load. According to the definition we classify load as dynamic when its attachment causes propagation in material stress in the form of a wave. The mechanisms of impact course and also its effects are not yet known or described in a satisfying way. However, measuring techniques development in the last years has created a possibility of measurement with sufficient accuracy of force, acceleration, velocity and deformation courses and determining the speed of pressure wave spreading in a sample during an impact. Having such data conclusions can be made about the response of plant material tissue to dynamic load on the basis of course and not only observation of impact effects in a reliable way.

The most appropriate indicators describing bruise susceptibility are: the bruise threshold and the bruise resistance [Bajema & Hyde, 1998; Mathew & Hyde, 1997]. These indicators are based on strength features of plant tissues determined in an objective way. One of these indicators is the bruise threshold defined as a drop height, at which bruise of a sample at a specific mass, shape and impact surface appears. To establish the bruise threshold the method of multiple apple drop from systematically increased height was used. It consists in twofold dropping of subjected fruit from a given height and increasing it by the assumed value up to maximum drop height which in this case amounted to 22 mm. Its value was determined on the basis of preliminary research and the analysis of technological processes.

During each drop the course of response force in time was recorded. For successive drops from the same height which did not yet cause damage of apple tissue, response force courses will overlap with each other. Whereas as the bruise threshold should be assumed the value of drop height, at which significant variances appear between successive response force curve courses recorded during consecutive drops.

Occurrence of mechanical damage in fruits and vegetables became a reason which made it necessary to investigate and describe fruit and vegetable resistance to mechanical load. Not only is the description of strain development damaging apple tissue interesting but it is also important to make an attempt to minimize the effects of the damage. Comprehension of these mechanisms will enable to predict an influence of different factors and parameters on quality and size of damage.

The aim of this study was to determine the influence of apple features such as: moisture content, water potential, firmness (measured by means of Magness-Taylor penetrometer) on the bruise threshold of Melrose variety apples.

MATERIAL AND RESEARCH METHOD

In 2006 the research on Melrose variety apples was carried out. 50 apples were tested in total . Measuring series were conducted for 10 apples every 7 days for the period of 28 days counting from the harvest day. The apples were directly placed after the harvest in a room with a fixed temperature and next, after the 12-hour storage, the measurements were started. Before the appropriate impact test mass and maximum apple diameter measurements were performed. To carry out the impact research, pendulum device was used with an apple as an impactor. The complete description of the measuring stand is in the article of co-authors [Stropek & Gołacki, 2007].

MOISTURE CONTENT MEASUREMENT

For moisture content measurement the sample for each tested apple of a cylindrical shape 12 mm diameter and 15 mm length was taken. The moisture content of the apples was by the drying method . It consisted in finding the difference of the sample mass before and after drying at 105ºC temperature. Ground specimens were placed in weighing bottles and weighed with the accuracy of 0,01 g. Next they were put in a dryer and dried until the sample mass was fixed. From the dryer the specimens were moved for 20 minutes to exsiccator and next were weighed on a laboratory scales. The moisture content of the sample was calculated from the formula:

$$w = \frac{(m - m_1)}{m} \cdot 100 \ [\%], \tag{1}$$

where: w – apple moisture content [%];
m – fresh sample mass [g];
m_1 – sample mass after drying [g].

WATER POTENTIAL MEASUREMENT

Water potential measurement was carried out by means of Wescor company device consisting of a microvoltmeter RH-33T and a container for the samples C-52. For the measurement was used a psychometric method which consists in temperature measurement of air dew-point in direct closeness to plant tissue [Gołacki, 1994; Gołacki, 1997; Gołacki & Obroślak, 1997; Szot & Gołacki, 1987]. The measurement was performed on rollers of 9 mm diameter and 5 mm thickness taken from an apple. After that the sample was closed in a hermetic container of a capacity near to the specimen volume, in which after a specific time temperature balance and water vapour pressure above and in the sample was settled. The minimum time to achieve the balance for the specimen was 15 minutes established experimentally. After cooling the sample the voltage value on the scale was read and next compared with calibration graph, from which water potential value was read in MPa.

MAGNESS-TAYLOR TEST

The firmness of each apple was determined directly after the impact measurement by means of Magness-Taylor penetrometer universally used in fruit farming [Puchalski 1993, Rybczyński & Dobrzański 2002, Kuczyński 2003]. The shank in the shape of a 11 mm diameter cylinder and with a spherical tip was applied. The measurements were carried out in three points located on the maximum diameter according to the diagram presented in Fig. 1.

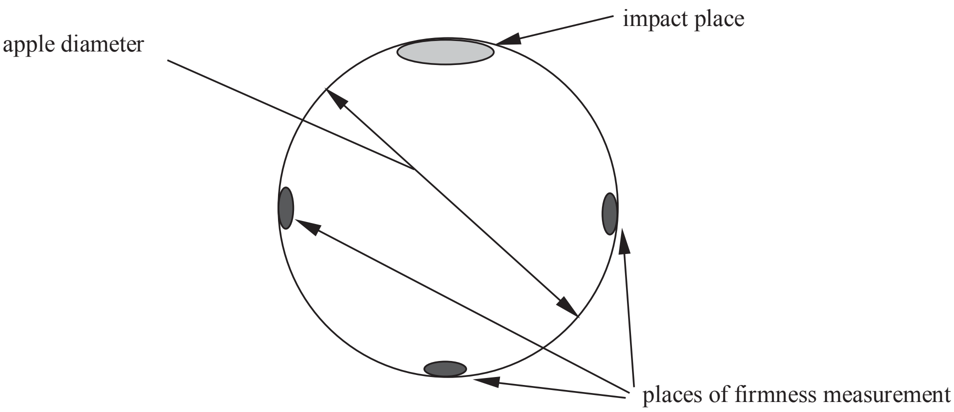

Fig. 1. The diagram of point placement to determine firmness by means of Magness-Taylor test

Thanks to three measurements performed on one apple it was possible to use the average value of fruit firmness for further analysis. In order to standardize firmness measurement test, the research was conducted by the same person.

RESULTS AND DISCUSSION

The influence of moisture content on bruise threshold

Apple moisture content decreases along with the extension of the storage period (Fig. 2). The skin of an apple becomes more slack and dried up. Assuming the description of apple rheological properties by means of Maxwell model, in which viscoelastic apple structure is represented as a parallel connection of the spring and damper, slack an apple skin causes the increase of damping coefficient. The apple skin becomes also a protective layer for apple tissue devoid of water. From the point of view of the strength properties of an apple structure that is a desired effect, as it is more difficult to cause failure stresses. However, due to its appearance, the apple cannot be yet passed to a consumer market.

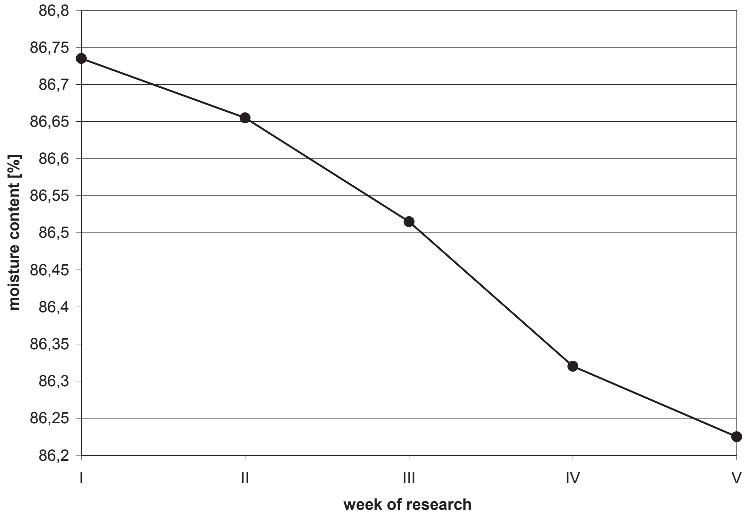

Fig. 2. The average value of moisture content in separated weeks of research

The research showed a considerable influence of moisture content on bruise threshold value. Along with the decrease of moisture content, the bruise threshold value increased.

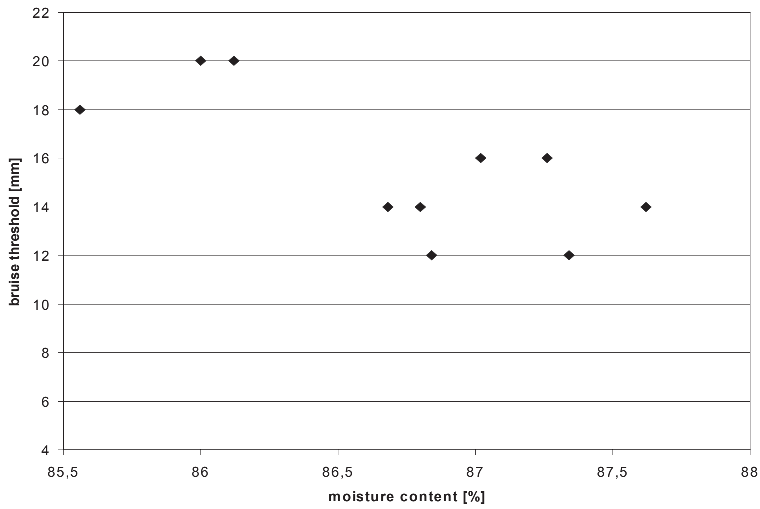

Fig. 3. The influence of moisture content on bruise threshold value in the first week of research

This influence is seen both in separated series (Fig. 3.), and for the average values of moisture content during four-week storage period (Fig. 4).

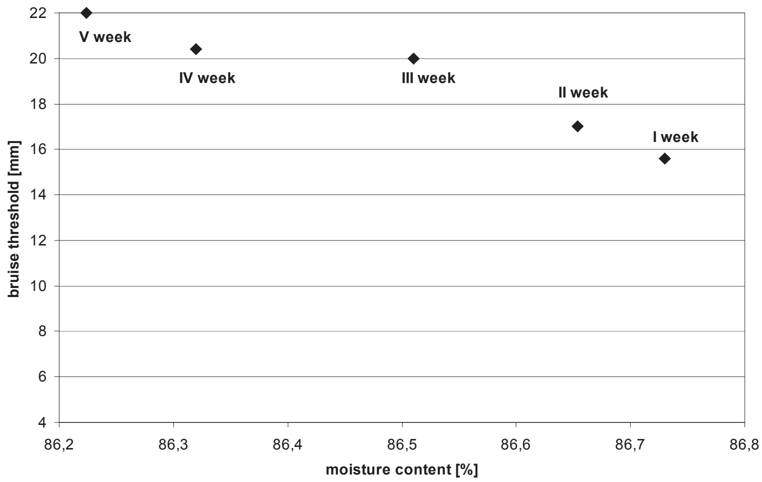

Fig. 4. The relationship between the average value of bruise threshold and the average value of moisture content in consecutive weeks of research

The influence of water potential on bruise threshold

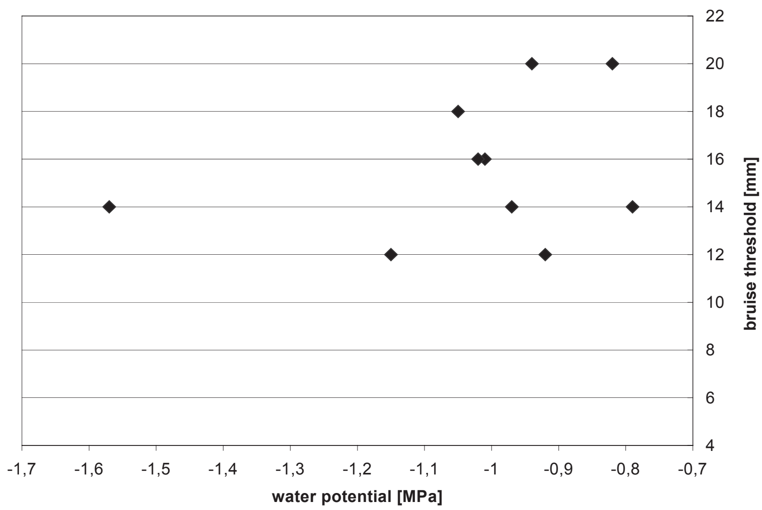

Fig. 5. The relationship between bruise threshold and water potential in the first week of research

Water potential is directly connected with an intercellular pressure called turgor. Turgor is defined as a cell hydration condition. Its value depends on tension of plant cell membranes caused by the pressure of cell sap on cell walls [Garcia *et al*., 1995; Bajema *et al*., 1998]. The turgor level is equated with the firmness and physical condition of an apple.

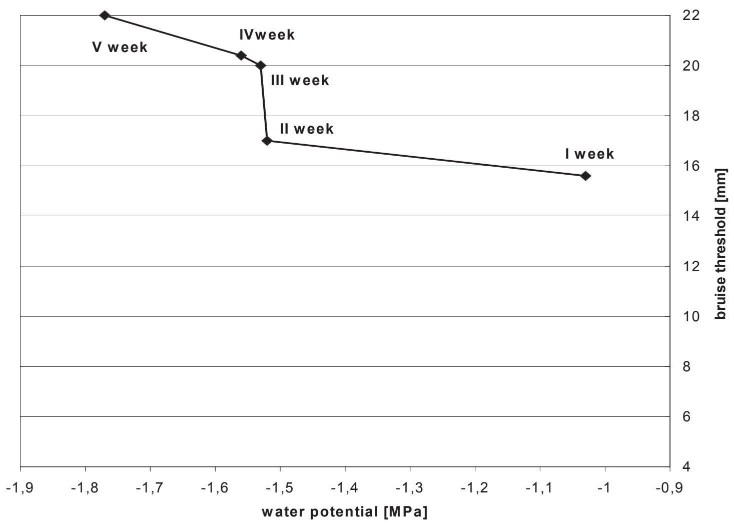

Fig. 6. The relationship between the average value of bruise threshold and water potential in consecutive weeks of research

A significant relationship between bruise threshold and water potential was not statistically stated in the range of one measuring time limit for the apples directly after the harvest (Fig. 5). In consecutive weeks of the research the tendency for an increase of bruise threshold in the function of decreasing water potential value was stated (Fig. 6).

An influence of firmness on bruise threshold

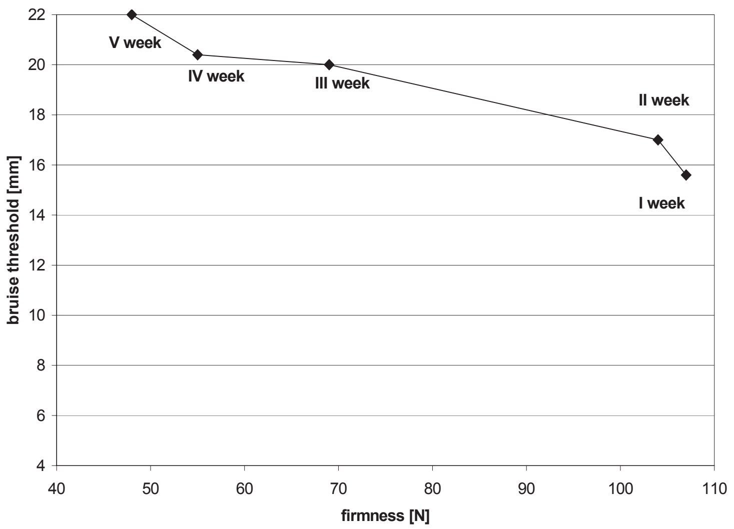

Fig. 7. The relationship between the average value of bruise threshold and firmness in consecutive weeks of research

Apples firmness does not remain without an influence on bruise threshold value of apple. It should be noticed that the firmness determined by means of Magness-Taylor test even if the measurements were performed by one person is not a fully objective indicator. In relation to that only the average values of bruise threshold depending on the firmness in separated weeks of the research were compared (Fig. 7). In Fig. 7 one can notice an increase of bruise threshold value together with a decrease of apple flesh firmness in consecutive weeks of the research.

CONCLUSIONS

- Moisture content most strongly affected the bruise threshold. The apples with higher moisture content had a significantly lower bruise threshold. That shows lower susceptibility to plastic strain. This tendency appeared in all the weeks of research.
- Water potential, the parameter closely connected with the intercellular pressure (turgor, had an influence on bruise threshold value. The intercellular pressure is higher for apples directly after harvest on account of higher water and air content. In the research it was confirmed that the influence of water potential value on bruise threshold is the strongest for apples directly after harvest and decreases with the storage time.
- Even though firmness is not considered an objective indicator at present, its usefulness was stated for apples ripeness estimation and for their preliminary selection

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WPŁYW WYBRANYCH CECH JABŁEK ODMIANY MELROSE NA PRÓG OBICIA

Streszczenie. W artykule określono wpływ parametrów takich jak: wilgotność, potencjał wody, jędrność na próg obicia jabłek odmiany Melrose podczas czterotygodniowego okresu badań. Próg obicia definiowany jest jako wysokość spadku, przy której pojawia się stłuczenie próbki o określonej masie, kształcie i powierzchni udaru. Aby wyznaczyć próg obicia użyto metody dwukrotnego uderzenia dla spadków z wysokości od 4 do 22 mm. Do przeprowadzania badań udarowych zastosowano stanowisko pomiarowe wykorzystujące zasadę działania wahadła przy czym elementem uderzającym było jabłko.

Słowa kluczowe: próg obicia, jabłko, udar, wilgotność, potencjał wody, jędrność.