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A SPECTROPHOTOMETRIC METHOD FOR THE ASSESSMENT OF THE MECHANICAL STRENGTH OF RASPBERRY FRUITS

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A b s t r a c t. Fresh raspberries from a plantation are transported over considerable distances. This leads to rapid - though slight - damage to the fruits, the first manifestation of which can be juice seepage. A new method has been developed for the assessment of the mechanical resistance of a mass of raspberry to dynamic damage. The measure was the juice seepage values.

The cylinders with samples of 50 fruits were subjected to horizontal vibration at a frequency of 4 Hz and an amplitude of 12 mm for periods of 5, 10, 20, 40 and 60 min. After the vibration, 250 ml of Sorensen buffer was added to the fruit in the cylinders. The quantity of juice in the buffer was determined by means of a spectrophotometric method. The mechanical strength of fruits of six varieties was compared. The determination of the effect of such factors as temperature, ripeness, variety and the duration of vibration on the variability of the juice seepage was made.

K e y w o r d s: raspberry fruits, fruit damage, mechanical strength

INTRODUCTION

Fresh raspberries from a plantation are transported over considerable distances [7], and mechanical vibration results in mutual friction and impacts among the fruits. This leads to rapid - though slight - damage to the fruits, the first manifestation of which can be juice seepage. Juice seepage facilitates gradual compaction of fruit mass in individual packings. Also, the usually close positioning of the packings makes air circulation difficult. In this situation, fruit respiration, increased at even slight damage, quickly results in a considerable increase in temperature and humidity, i.e., to the fruit becoming over-heated, which makes the fruit useless as fresh trading material. Therefore, juice seepage results not only in quantitative losses, but also, and primarily, in the aggregation of fruits and in a rapid increase in microbiological infection, i.e., in enormous qualitative losses to the material.

Research dealing with fruit damage during transport can be classified in two basic groups of studies. The first includes studies aimed at describing, modelling, and providing causes of mechanical damage [1,4,5]. Their basis, and means of verification, are measurements of the mechanical parameters of the fruits and of the external factors affecting the fruits under transport conditions. The second group consists of experimental studies, minimizing the damage through the selection of suitable varieties, degree of fruit ripeness, optimum temperatures, and maximum allowable duration of transport [2,3,6]. In both groups of studies the main problem is the lack of an objective method of measurement, or at least of assessment of the mechanical damage to fruits during the initial phase of transport.

The objective of this report is the presentation of a new method of study on dynamic damage of raspberry fruits.

MATERIAL AND METHOD

The study was conducted on the fruits of 6 varieties of raspberry: Canby, Malling

Jewel, Malling Promise, Nootka, Norna, and Veten. The material originated from an experimental plantation of the University of Agriculture, Lublin. The fruits were picked at 2-3 day intervals, always at harvest ripeness. They were picked as samples of 50 fruits each and placed in carton boxes. For the methodological studies, the fruits were sorted into two ripeness classes: I - fruits of lower ripeness, and II - fruits of full ripeness, ready for consumption.

Fruits for experiments under the conditions of refrigerated transport were placed immediately at a temperature of 0 °C or 8 °C, and after cooling the experiments were carried out in cold storage rooms.

On the stand for dynamic tests, fruit samples of 50 fruits were placed in a plastic cylinder of a diameter of 95 mm, with 9 holes in the bottom, each of a diameter of 6 mm. Six such cylinders were weighed and placed in fitting containers attached to a vibrator. The cylinders with fruits were subjected to horizontal vibration at a frequency of 4 Hz and an amplitude of 12 mm for periods of 5, 10, 20, 40 and 60 minutes. After the vibration, 250 ml of Sorensen buffer of pH 3.4 was added to the fruit in the cylinders. Then the cylinders with the fruit were removed, and the buffer, stained by the juice, drained through the bottom holes into the fitting containers.

The quantity of juice in the buffer was determined by means of a spectrophotometric method, using the determination of the concentration of anthocyanins in the buffered water solution through the measurement of absorption at wave length of 510 nm with relation to absorption of a reference solution decolourized with pyrosulphite. For the study, calibration curves were plotted using various concentrations (dilutions) of the solution with a known amount of juice from the seepage from fruits subjected to vibration. For the decolourization of the anthocyanins juice solution with an admixture of potassium pyrosulphite was used, at a ratio of 1 ml of pyrosulphite in 20 % solution per 15 ml of juice solution. The calibration curve plotted allowed for the determination of the mass of juice that seeped from the fruit, and for the expression of the seepage in percentages.

RESULTS AND DISCUSSION

Samples of fruits of various varieties which were not subjected to vibration did not differ statistically in their juice seepage values. The seepage values varied from 0.12 % (mean value for the M. Jewel variety) to 0.44 % (for Norna), with the least significant difference of 1.52 %.

In the study, the effect of the duration of vibration on the value of juice seepage was tested up to 60 min (Fig. 1).

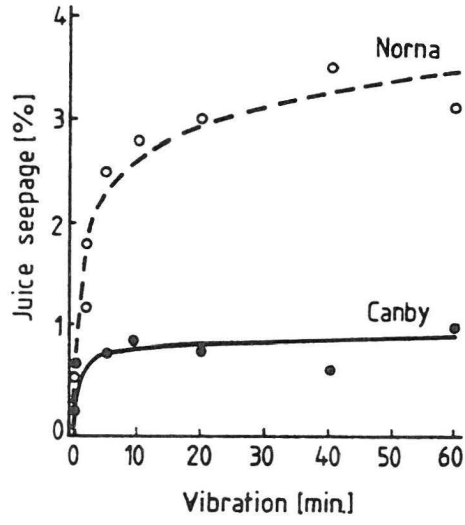

Fig. 1. The effect of vibration time on the level of seepage for two varieties of raspberry.

It can be stated that the basic process of damaging the fruits and of the juice seepage occurred in fact only during 10 min. This was observed both for varieties of relatively low seepage (Canby) and of relatively high seepage (Norna). The same conclusion follows from a comparison of 4 varieties of raspberry subjected to vibration for periods of 0, 10, and 20 min (Fig. 2).

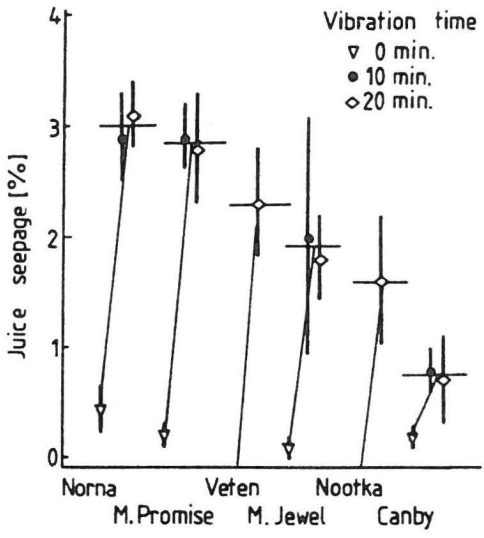

Fig. 2. Juice seepage values for fruit with no mechanical damage and after 10 and 20 min of vibration, for several varieties of raspberry.

The differentiation in the value of juice seepage for samples of different varieties obtained after 20 min of vibration was very high, the values varying from 0.2 % (minimum for Canby) to 7.3 % (maximum for Norna).

A strong effect of ripeness on the seepage of juice from fruit was observed in varieties characterized by low as well as high levels of seepage (Fig. 3). A decrease in the ripeness of the raspberries subjected to vibration for 20 min reduced the seepage by a factor of 2.5 (Norna) up to 5.2 (Canby).

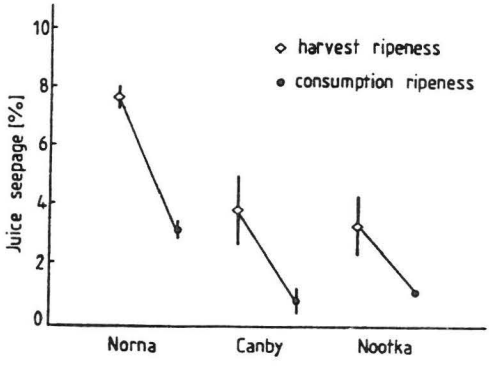

Fig. 3. Juice seepage reduction through decrease the ripeness of the fruit of 3 varieties of raspberry.

In order to compare the simultaneous effect of a number of factors, the experiment was conducted for three years, on 4 raspberry varieties (Canby, Nootka, Norna, Veten), for three levels of temperature of the fruits (0, 8, and 24 °C). Fruits picked at harvest ripeness were subjected to vibration for 20 min. A very high statistical significance was established for these factors, as well as significance of interactions between varieties and temperatures.

Among the varieties, the highest level of seepage was observed in the Norna variety (3.8 %), and the lowest in the Canby (1.2 %) and the Nootka (1.3 %) varieties (Fig. 4). Lowering the temperature of the fruits resulted in a decrease in juice seepage only in the case of varieties characterized by the highest seepage values - Norna and Veten. However, there was no statistical difference between the effect of the temperature of 0 °C and of 8 °C.

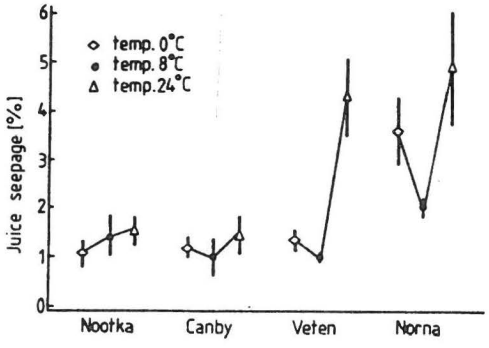

Fig. 4. The effect of fruit cooling on the value of juice seepage for 4 varieties of raspberry.

The effect of the years of the experiment was notable in that distinctly lower levels of seepage were observed in the first year of the study - mean value of 1.39 %, while in the second and third year the corresponding values were 2.38 % and 2.71 %, respectively.

CONCLUSIONS

Several years of experiments concerned with raspberry fruits permit the formulation of the following conclusions:

1. Juice seepage from fruits subjected to vibration in containers takes place during the first 10 min and varies, depending on the variety, ripeness level and fruit temperature, from 0.2 % to 7.3 % of the fruit mass (at vibration frequency of 4 Hz and amplitude of 12 mm). It can be assumed, therefore, that transport lasting for longer periods should not cause any increase in seepage if it results only from mechanical vibration.

2. The fruits of the varieties studied differed strongly in their seepage values (from 1.2 % to 3.8 %), which substantiates the applicability of the method for the selection of raspberry varieties.

3. In varieties characterized by high seepage levels a lowering of fruit temperature, e.g. to 8 °C, reduces the seepage several times, stabilizing its value at the level of varieties of low seepage values.

4. Even a slight decrease in the ripeness of raspberries effectively reduces the juice seepage by a factor from 2.5 to 5.2.

5. Variety ordering as to their mechanical strength obtained from the study is consistent with the opinion of growers.

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