DEPENDENCE OF MECHANICAL TOUGHNESS OF PEACH STONE ON DATE OF HARVEST

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Abstract

Properties of peach (*Red Heaven*) stones were studied by many different methods, for example proportion and mass, or through measurement shape of surface by means of 3D scanning. In this work we consider evaluation toughness of peach stones in dependence on date of harvest by using multi-purpose test machine Zwick Z050 which pressed a stone in given direction. Toughness was evaluated from proportions of stones, maximal compression and force at rupture.

Key words: toughness, peach stone, rupture

Introduction

The stone occupies large part of peach volume, therefore it plays an important role in properties of the peach as a whole and hence it is desirable to study its characteristics. Volume and mechanical properties of a peach can affect maturation age, or durability live of fruits and are therefore of great significance in agriculture. Knowing these parameters, to which the peach stone contributes, we can find optimal date of harvest, or storage conditions such as temperature or optimal number of peach in one packet.

We examined Red Heaven peach, which have been harvested in south Moravia, Czech Republic. Toughness was measured periodically - one set of measurements each week for four weeks. The samples were harvested at 14.7, 21.7, 28.7 and 4.8. 2008. The peaches from last two dates were ready for consummation. Let us note the year 2008 was extremely above-normal in temperature and an ordinary in rainfall [1] as a whole.

Type of dates \ Month	1.	2.	3.	4.	5.	6.	7.	8.
Mean Precipitation Amount (mm)	20	12	41	35	57	55	74	52
Long-Term Normal 1961–1990 (mm)	30	30	29	38	65	75	64	61
Mean Precipitation Amount as Percentage of the Long-Term Normal	67	41	145	94	88	74	116	86

Mean Precipitation in the Year 2008 Compared with the Long-Term Normal 1961–1990 for south Moravia [2]

Type of dates\Month	1.	2.	3.	4.	5.	6.	7.	8.
Monthly Mean Air Temperature (° C)	1,5	2,6	4,1	9,4	14,8	18,8	19,5	19,1
Long-Term Normal 1961–1990 (° C)	-2,6	-0,6	3,4	8,6	13,5	16,6	18,1	17,6
Deviation from Long-Term Normal (° C)	4,1	3,2	0,7	0,8	1,3	2,2	1,4	1,5

Mean air temperature in the year 2008 compared with the long-term normal 1961-1990 for south Moravia [2]

Type of dates\Month	1.	2.	3.	4.	5.	6.	7.	8.
Mean Air Temperature (° C)	2,1	3,2	5,1	10,5	15,8	19,8	20,3	20,1
Total Precipitation (mm)	17,3	11,5	34,7	24,0	63,8	44,9	50,4	34,9
Sunshine Duration (h)	60	113	156	193	260	266	226	246

Date from Hydrometeorological station Velké Pavlovice in south Moravia [2]

Material and methods

Peach stones

We studied four groups of samples with different dates of harvest. The first group is represented by seventeen stones, the second by thirteen, the third by eleven and the fourth by twelve. Different number of representatives is given by discard dates of some samples before elaboration. The peaches were obtained from the orchards of the Department of Postharvest technologies, Lednice, Mendel University of Agriculture and Forestry in Brno. Measured peaches were get off pulp and cleaned by scalpel.

Toughness - theory

Toughness (P) of a peach stone is, of course, affected by its dimensions (width, length, thickness). One also needs to know the rupture force (F) which is maximal force by which a stone is irrevocably deformed. Last quantity necessary for calculating the toughness is the deformation at rupture point (D) which denotes maximal thickness compression before irrevocable deformation. Toughness is expressed as the energy (E) absorbed by a peach stone up to rupture point per unit volume (V) [4]

$$P = \frac{E}{V} \,. \tag{1}$$

As we can see in graph 1., deformation force depends on compression approximately linearly (up to rupture). Therefore we can safely approximate the energy by a simple form

$$E = \frac{F\,D}{2}, \tag{2}$$

thus avoiding numerical integration of the measured dependence of F on compression.

Peach stones are of ellipsoidal shape and their volume is approximately given by term [5]

$$V = \frac{\pi(\text{width}.\text{length}.\text{thickness})}{6}. \quad (3)$$

Toughness – measurement methods

Each peach stone was compressed along the Z-axis (along the shortest side of stone, corresponding dimension is thickness) by tensiometer Zwick Z050 (with maximal force 50kN). The measurement data were already partially analysed by computer programme Test Xpert. v5.01, which is a user interface to the Zwick Z050 device. Test Xpert. v5.01 output was analysed further using Microsoft Excel.

Methods evaluation data

Standard statistical methods were applied to the datas. Mean toughness <P> is given by

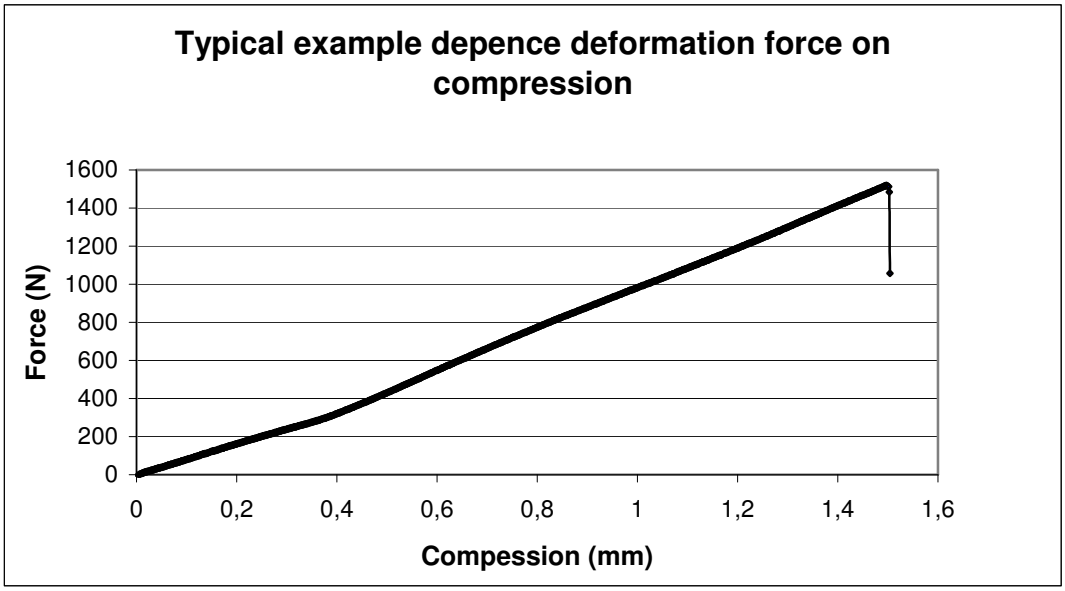
$$\langle P \rangle = \sum \frac{P_i}{n}. \quad (4)$$

P_i is toughness of one stone and n is number of all measurements in a given group of samples. Mean quadratic deviation toughness was computing by equation

$$\delta P = \sqrt{\frac{\sum (P_i - \langle P \rangle)^2}{n^2 - n}}. \quad (5)$$

Results and discussion

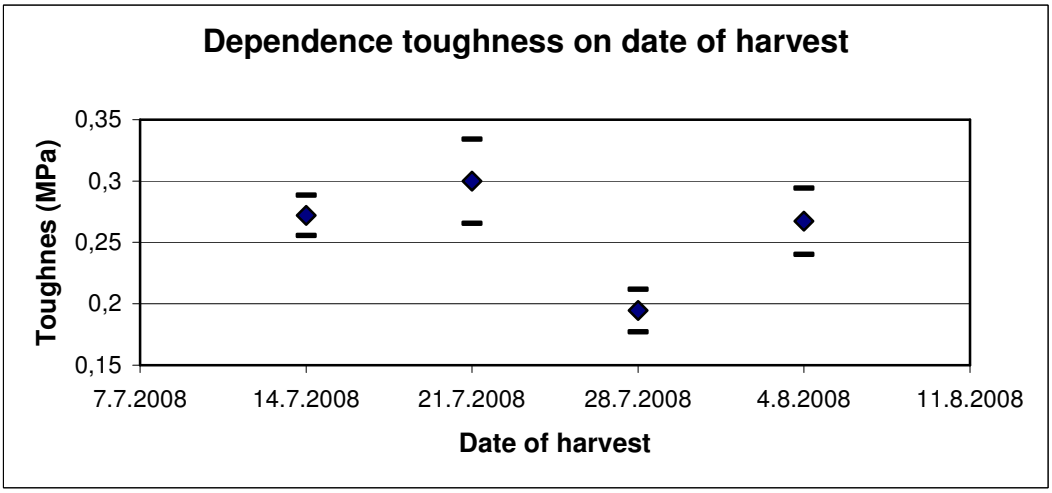
As we said hereinbefore deformation force depends on compression until rupture nearly linearly. This dependence we can see in graph 1.



Graph 1.

The rupture point and rupture force are easy to see in the graph 1..

The graph 2. shows dependence toughness on date of harvest with mean quadratic deviation for each group of samples indicated by the error bar.



Graph 2.

Results of toughness are written in table 1.

Time of harvest/Data from evaluating	Mean toughness (MPa)	Deviation toughness (MPa)
14.7.2008	0,272	0,016
21.7.2008	0,30	0,03
28.7.2008	0,195	0,017
4.8.2008	0,27	0,03

Table 1.

We see that values of toughness of different groups are relatively close to each other. Toughness of the third group of samples is lower than the other values.

One may expect a monotonous trend, such as increasing of the toughness in time. Discrepancy of the expectation and our results may be due to low number of samples in the third group. Our data are in fair correspondence with similar results of toughness of apricot pit in [4].

Conclusions

We did not find significant dependence of peach stone toughness on time of harvest during final periods of maturation. Individual values of toughness, of the stones within each group, vary heavily thus producing large mean quadratic deviation. This did not enable us to find if there is a dominant trend in dependence of toughness on date of harvest. For this reason, it is desirable that next measurements are based on larger sets of samples. On the other side, our results are in fair agreement with another works. Mean toughness lies within the interval (0,2, 0,3)MPa.

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