Int. Agrophysics, 1994, 8, 299-303

THE TECHNOLOGICAL PROPERTIES OF THE PEA SEEDS

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A b s t r a c t. The seeds of two pea varieties Bohatyr and Junak were separated from the cropstand during the ripening. The biological seed moisture content ranged within 70-10 %. In relation to the decreasing seed moisture content the changes of size and weight characteristics, coefficient of restitution after the rebound from wooden, concrete and steel plate, were investigated. The changes of force causing the mechanical seed destruction were measured by using of compression testing device INSTRON 1112 as effected by seed moisture content and loading-force direction.

K e y w o r d s: pea seeds, technological properties

INTRODUCTION

In relevant scientific papers interaction between seed technological properties and their moisture content is well described. The attention of scientists [2-10] has been mostly paid to the range of seed moisture content from the point of storing conditions (moisture content less than 15 %). Other authors studied the range of seed moisture content in relation to the harvest conditions (moisture content more than 25 %). As the pea is harvested also as 'green pea', it is interesting to know the relation of technological properties of pea seeds and their high moisture content (60-70 %). In such experiments it is necessary to manage factors effecting the results to the conditions which are adequate from the point of high moisture content when pea seed is processing.

METHODOLOGY

The seeds of two pea varieties (Bohatyr and Junak) were chosen as the object of investigation. The following seed properties were studied:

- size and weight parameters,
- coefficient of restitution,
- the force causing the mechanical destruction.

The seeds chosen for the experiment were harvested by hand, gradually during their ripening. The range of moisture content of the selected seeds was following:

- variety Bohatyr: 68.2-13.3 %,
- variety Junak: 75.1-12.9 %.

The relation between size and weight of the seeds is expressed through the seed density σ:

$$\sigma = G/V, \tag{1}$$

where G is weight and V is volume of the seeds calculated for the equivalent spherical volume, where average radius r_s of the seeds is following:

$$r_s = 1/2\ (l\ b\ h)^{1/3}, \tag{2}$$

where l, b and h are seed length, width and thickness, respectively.

The coefficient of the restitution (ε) was determined for the free fall on the plate made of different materials (steel, wood, concrete). The value of this coefficient was determined from the equation:

$$\varepsilon = (h/H)^{1/2} \tag{3}$$

where h is height of seed rebound from the plate and H is height of the seed fall.

The force causing mechanical destruction of the seed was read out from force-deformation curve in bioyield point [1,3,8]. Experimental deformation curves were obtained on the laboratory measuring device INSTRON 1112 with data recording processing on the personal computer. The loading forces were directed on the seeds in direction of their length, width and thickness. Simultaneously, the seed size values were recorded. The analytical balances SARTORIUS were used to determine the seed weight. All tests were repeated for fifty times.

RESULTS

The size of seeds was measured in three plains perpendicular each to other, according to the direction of their germ leaves. Each data file was indipendently evaluated and tested. All data files had normal distribution. It is possible to evaluate dependence of the size and weight changes of pea seeds on decreasing seed moisture content during the ripening by using the regression analysis and can be expressed by function $y = A + B\,W + CW^2$, where y - size or weight of the seed, W - seed moisture content in %.

Interaction between seed size and weight is expressed through seed density (Fig. 1).

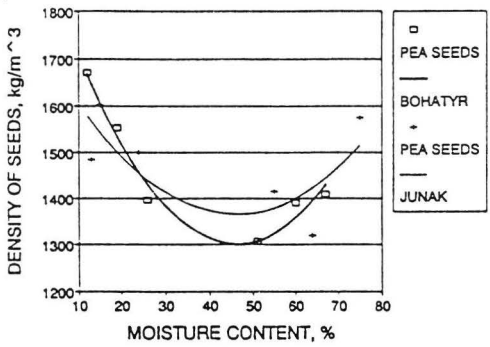

Fig. 1. Pea seed density vs. seed moisture content during the ripening for Bohatyr and Junak varieties.

Regression coefficients and correlation coefficients of the size and weight parameters and pea seed density (variety Bohatyr and Junak) with the natural seed moisture content 13-68.2 % are given in Table 1.

Coefficients of restitution were measured on the basis of seed rebound from the plates made of wood, concrete and steel. During the ripening the values of coefficient of restitution

Table 1. Regression and correlation coefficients of the size and weight seed parameters and pea seed density for Bohatyr and Junak varieties

Seed parameter	Coefficients of			
	regression			correlation
	A	B	C	
		Bohatyr		
Length (mm)	6.301	0.112	-9.579E-04	0.963
Width (mm)	3.780	0.246	-2.776E-04	0.900
Thickness (mm)	5.580	0.100	-8.366E-04	0.930
Weight (mg)	111.396	15.505	-0.149	0.950
Density (kg m^{-3})	2000.120	-29.358	0.308	0.980
		Junak		
Length (mm)	6.012	0.152	-1.342E-03	0.932
Width (mm)	6.036	0.115	-1.104E-03	0.944
Thickness (mm)	5.321	0.151	-1.491E-03	0.997
Weight (mg)	122.735	17.707	-0.159	0.977
Density (kg m^{-3})	1753.554	-16.716	0.180	0.686

Dependences of coefficient of restitution during the ripening related to the different plates are expressed in Fig. 2. Coefficients of regression and coefficients of correlation for coefficient of restitution of pea seeds are given in Table 2.

The interaction between factors effecting the changes of coefficient of restitution (variety, plate material and seed moisture content) were evaluated by means of multifactor analysis of dispersion. Achieved results are given in Table 3.

The changes of coefficient of restitution are caused first of all by seed moisture content. The effect of other factors (variety and plate materials) is less significant.

The force causing mechanical destruction of the seed was measured by compressing of seeds in the direction of their length, width and thickness.

The dependence of force read from the force-deformation curve in bioyield point has during the seed ripening the form of power function. Given function we can evaluate by using the regression analysis to the function form $y = A\,B^{W}$, where y - value of the force (bioyield point), W - seed moisture content in %.

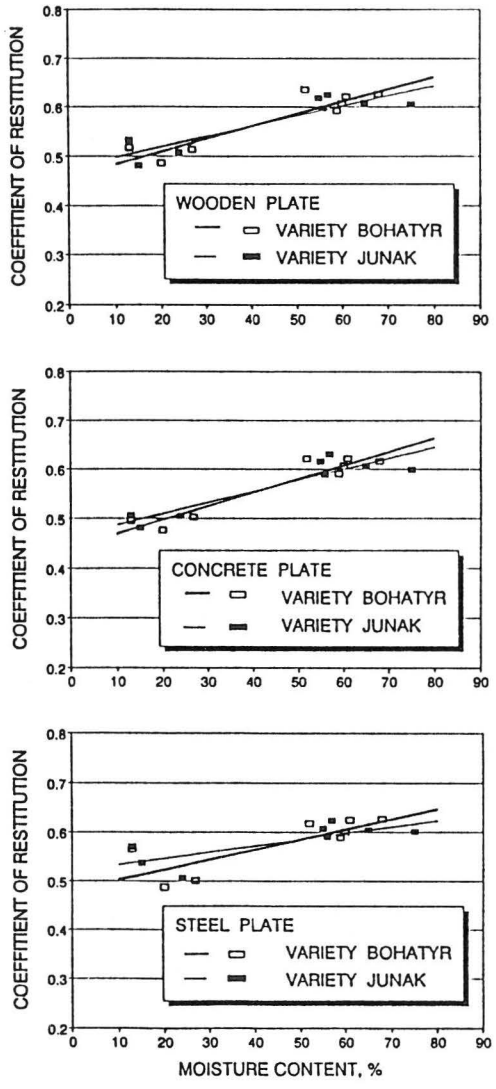

Fig. 2. Pea seed coefficient of restitution as a function of ripening related to different plates for Bohatyr and Junak varies.

Table 2. Regression and correlation coefficients of restitution coefficient for pea seeds of Bohatyr and Junak varieties for wooden, concrete and steel plates

Variety	Coefficients of regression A	Coefficients of regression B	Coefficients of correlation
		Wooden plate	
Bohatyr	0.459	2.54E-03	0.921
Junak	0.477	2.08E-03	0.901
		Concrete plate	
Bohatyr	0.442	2.77E-03	0.955
Junak	0.464	2.25E-03	0.918
		Steel plate	
Bohatyr	0.483	2.06E-03	0.808
Junak	0.521	1.28E-03	0.776

Table 3. Multifactor dispersion analysis

Effecting factor	f	F	P (%)
Variety	1	10++	0.8
Plate	2	15++	2.2
Moistutre content	3	430++	89.7

f - degree of freedom, F - calculated value of F - test, P - factor variability.

Relation between the force causing the mechanical destruction of the seed and the seed moisture content changed during the ripening with regard to the different directions of compressions are given in Fig. 3. Coefficients of regression and coefficients of correlation of investigated functions are given in Table 4.

Interaction between the factors affecting the force which causes mechanical destruction of seeds (variety, direction of force, seed moisture content) were evaluated by using of multifactor dispersion analysis. The results are given in Table 5.

The value of the force causing mechanical destruction of the seeds significantly depends upon the seed moisture content. The effect of the direction of force was evident only for the seeds with the moisture content under 35 %.

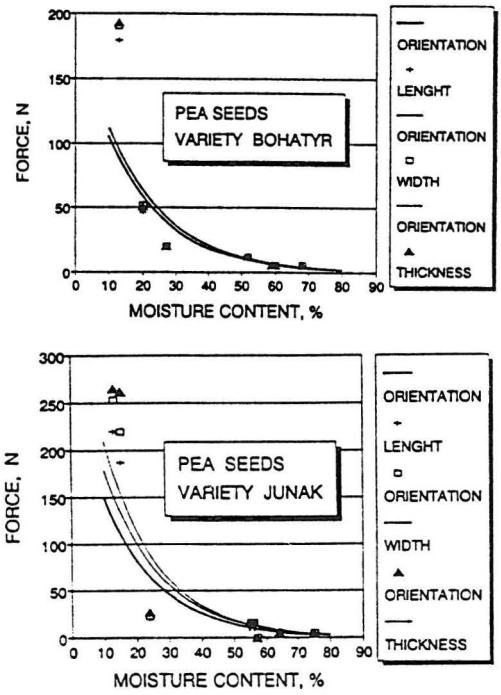

Fig. 3. The force causing mechanical destruction of the seed vs. seed moisture content during the ripening for Bohatyr and Junak varieties.

Table 4. Regression and correlation coefficients of length, width and thickness for Bohatyr and Junak pea seed varieties

Force orientation	Coefficients of regression A	Coefficients of regression B	Coefficients of correlation
	Bohatyr		
Length	187.59	0.94	0.795
Width	197.81	0.94	0.797
Thickness	198.61	0.94	0.792
	Junak		
Length	266.64	0.94	0.828
Width	318.61	0.94	0.839
Thickness	382.70	0.94	0.856

Table 5. Multifactor dispersion analysis

Effecting factor	f	F	P (%)
Variety	1	9.7++	0.4
Plate	2	1.7++	1.1
Moistutre content	3	690.3++	96.9

Explanations as in Table 3.

CONCLUSIONS

Basing on the results obtained in this study we can state that there is significant effect of the seed moisture content on the investigated seed properties. As the seeds were separated from the cropstand just before experiments, the seeds moisture content changes determine the process of ripening.

Studying the seed properties within the whole range of seed moisture contents allows more deeply characterize their interaction by using of regression analysis.

The effect of seed moisture content on the seed properties has the same character as far as other additional factors one concern (variety, plate material, direction of force, etc.).

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