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POISSON'S CONSTANT DETERMINATION OF SELECTED LEGUMES AND OIL SEEDS

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A b s t r a c t. The legumes seeds - bean variety Herzfreier, lentil variety Lenka and oil seeds - poppy variety Amarin, rape variety Silesia and sunflower variety IBH-166 were chosen for investigation. Poisson's constant of the seeds is determined according to methodology by Kustermann et al. [2,3] and with the aid of machinery equipments at the Institut für Agrartechnik Universität Hohenheim - Germany. Using this method a great emphasis must be laid on the input data. Especially value of the force causing mechanical destruction of the seeds, entering the calculations, can be determined in various ways. Some of them are presented by examples. The results of the experiments - values of the force causing cracking of seeds, deformation of seeds, compressibility, elasticity coefficient and Poisson's constant are supplemented with the values obtained by the experiments with maize and spring and winter barley to make comparison.

K e y w o r d s: legumes and oil seeds, Poisson's constant

INTRODUCTION

Elaboration of results of an experiment according to a well-known and well-tried methodology need not often lead to comparable results. As for the judgement of physico-mechanical attributes of seeds, the use of quantities obtained experimentally, as the basis for other calculations, it is important to consider the 'choice' of these values. The 'choice' of values of force causing the mechanical destruction of seeds also belongs to this kind of quantities able to influence the results of experiments.

METHODOLOGY

The following legumes and oil seeds were chosen as the object of investigation: bean - variety Herzfreier, lentil - variety Lenka, sunflower - variety IBH-166 and poppy - variety Amarin. The results from the work by Kutzbach *et al.* [4] were taken over for good measure and comparison. The value of force F causing cracking of seeds (bioyield point) and the value of seed deformation d by this force were taken off from force-deformation curve [1] ascertained by machinery equipment INSTRON 1112 at Institut für Agrartechnik - Universität Hohenheim and at the Department of Machines and Production Systems, University of Agriculture Nitra. Poisson's constant was determined according to methodology by Kustermann [2,3], with the aid of laboratory measuring devices of Institut für Agrartechnik Universität Hohenheim.

RESULTS

According to Kustermann [3], the value of Poisson's constant can be defined as:

$$\mu = 0.5 - E\,\frac{æ}{6} \qquad (1)$$

where æ - compressibility stated experimentally and E - elasticity coefficient can be stated from the relation:

$$E = \frac{[(æ\,C/6)-1]}{æ^2\,C/18} + \frac{[1-(æ\,C/6)^2]^{1/2}}{æ^2\,C/18} + \frac{(æ^2\,C^2/12)^{1/2}}{æ^2\,C/18} \qquad (2)$$

whereby the value:

$$C = 1.06/\pi\,(K^3/R)^{1/2}\,(F^3/d^3)^{1/2} \qquad (3)$$

The importance of the choice of F and d values for the calculation is evident from the Eq. (3). Possibilities of various ascertainment of the values are given by means of examples of choice of values of the force F causing cracking of the seeds, taken off from the force -deformation curve in bioyield point:

1) F values obtained by loading of the seeds by a force orientated in the direction of dimensions of the seeds: bean seeds (variety Herzfreier, moisture content of the seeds simulated in a laboratory 4.9-16.26 %) were loaded in the direction of their length, width and thickness (Fig. 1); the reached results are given in Fig. 2.
2) F values ascertained by close observation of the force-deformation curve: three considerable points can be localized on the force-deformation curve by the observation of the loading course (Fig. 3).

These points are very considerable by high moisture content of seeds and less considerable by the low ones. The comparison of valuation of the obtained points (pea seeds, variety Bohatyr, biological moisture content of the seeds 10-70 %, loading of the seeds in the direction of length) is given in Fig. 4. Dependences are approximated by the function $F = A \cdot B^W$, where W is moisture content

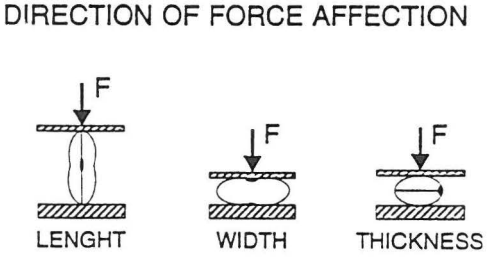

Fig. 1. Orientation of bean seeds by static loading.

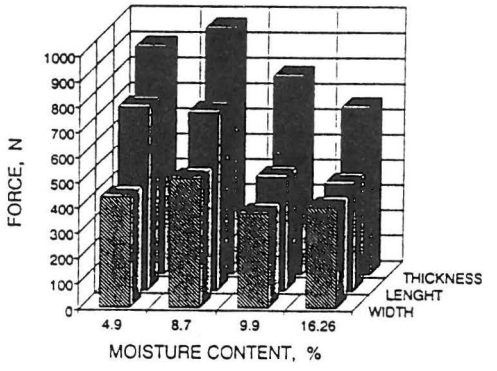

Fig. 2. Dependence of F on change of the moisture content of the seeds by loading orientated according to the dimensions of the seeds.

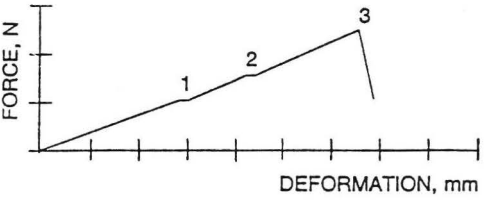

Fig. 3. Values of force damaging the seeds, remarked in the process of compression.

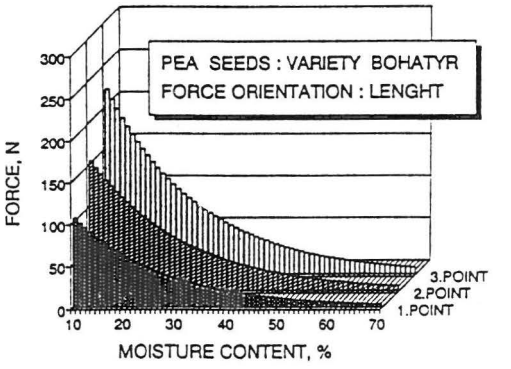

Fig. 4. Values of force damaging the seeds, remarked in various points of the force-deformation curve.

of seed given in %. Regression and correlation coefficients are given in Table 1.

Table 1. Regression and correlation coefficients

Point	Regression coefficient		Correlation coefficient
	A	B	
1	197.81	0.94	0.795
2	206.50	0.94	0.806
3	388.93	0.94	0.827

3) *F* values ascertained for seeds taken from variously great fruits: the same attributes of seeds taken from great fruits with different size of the same variety grown under the same conditions, have certain specialities; thickness of seeds and the force necessary for their cracking (sunflower seeds variety IBH-166, loading in the direction of thickness, moisture content of seeds 5.09 %), taken from fruits (heads) of various diameters are given in Fig. 5.

Influence of the choice of values F on Poisson's constant determination is evident from the results of experiments with sunflower and bean seeds (Fig. 6).

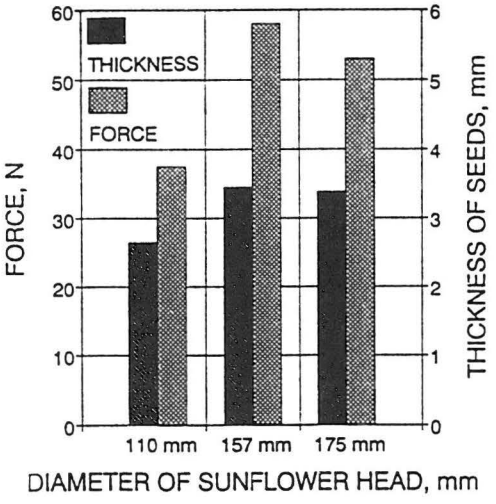

Fig. 5. Thickness of seeds and value of force damaging seeds taken from variously great heads of the sunflower IBH-166.

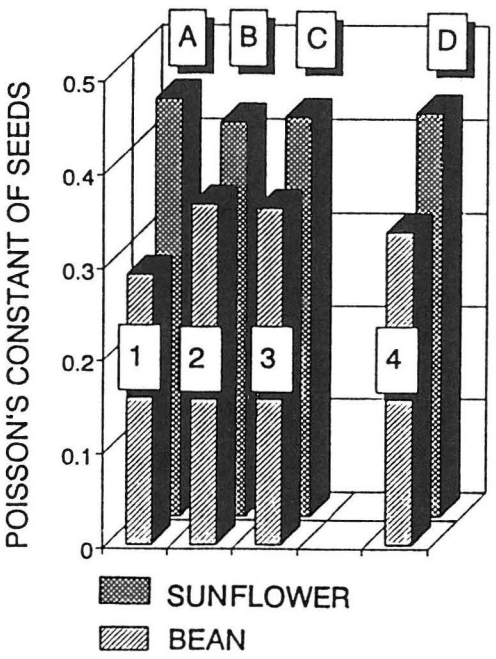

Fig. 6. Poisson's constant values of sunflower and bean seeds stated from various values F.

The results of experiments with the seeds of chosen varieties of legumes and oil plants and the obtained values of force (*F*) causing cracking of the seeds, deformations of the seeds (*d*) in this point, compressibility (æ), elasticity coefficient (*E*) and Poisson's constant (μ) are given in Table 2. The results are supplemented with the data according to Kutzbach [4] to make comparison.

CONCLUSION

On the basis of the mentioned experiments and experiences with published works it can be stated that the results presented without giving conditions of the experiment are only little applicable for comparison, respectively for realization of an analogical experiment, in many cases. Definition of the experiment conditions should include especially those input values which, though indirectly, could basically change the results.

Table 2. Results of the experiment

Plant variety	Moisture content of seeds (%)	Specific mass (kg m^{-3})	Equiv. diameter (mm)	F (N)	d (mm)	æ (mm^2 N^{-1})	E (N mm^{-2})	μ
Bean								
Herzfreier	8.70	1282.05	8.25	729*	0.44*	0.00275	916.37	0.0792
Sunflower								
IBH-166	5.09	842.10	5.41	49.4	0.39*	0.00549	74.07	0.4321
Lentil								
Lenka	8.40	1302.08	4.53	236.2$^+$	0.19$^+$	0.00363	1174.69	0.3290
Rape								
Silesia	6.02	703.33	2.35	14.12$^+$	0.31$^+$	0.00051	42.53	0.4963
Poppy								
Amarin	5.87	630.64	0.0012	2.47$^+$	0.12$^+$	0.00068	38.33	0.4956
Maize								
INRA 258**	10.00	1335.84	7.20	-	-	0.00240	430.55	0.3333
Spring barley								
Carina**	13.00	1299.00	3.66	-	-	0.00260	64.00	0.4930
Winter barley								
Dura**	11.00	1383.00	3.77	-	-	0.00360	112.20	0.4305

*medium value from the measurements in all directions of action of loading force, **according to Kutzbach [4], $^+$loading of seeds in the direction of thickness.

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