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EFFECT OF THE BIOLOGICAL AND SIMULATED MOISTURE CONTENTS OF CHICKPEA SEEDS (*CICER ARIETINUM* L.) ON THEIR PHYSICAL PROPERTIES*

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A b s t r a c t. The results of physical properties of agricultural products are often mentioned as a function of the change of their moisture content. If we try to compare the results of the works by other authors, we will notice accurate definition of the notion of material moisture content. A serious problem is right in the sphere of research on seeds. Experiments of some authors are executed with the biological moisture content; the time needed to execute the experiments is too short, the range of works are limited, it is not possible to repeat the experiments. A lot of authors employ samples with moisture content simulated in the laboratory; it is possible to prepare the material in storage, repeat the experiments and the methodology can be extensive. The aim of this work was to compare the results of selected physical properties of the seed chickpea (*Cicer arietinum* L.) which were found with the biological moisture content (BMC) and simulated moisture content (SMC). The sizes of seeds, the mass of seeds, the coefficient of restitution during the impact of seeds on the plate (steel, wood, concrete). At the same time, quasi-statical charged seeds where compared and the values of force and deformation were read from the force - deformation curve in the bioyield point (BP). Results obtained at BMC and SMC differ noticeably.

K e y w o r d s: physical properties, biological moisture content, moisture content simulated in the laboratory, chickpea seed

INTRODUCTION

We often work with the notion of moisture content while studying technological properties of agricultural materials. The moisture content of materials plays also an important role in the research on the physical properties of seeds. The moisture content alone and its asymmetrical distribution, varied binding energy of water in materials and its sorptive properties affect the physical properties of materials [4]. In principle, we can work with two groups of moisture content. The samples of seed with biological moisture content (BMC) are taken up directly in the process of crop growth. The samples of seeds with simulated moisture content (SMC) are represented by seeds naturally ripened which are moisturised in the laboratory for a certain time. We can perfectly follow changes inside the structure during maturity. It is impossible to store these seeds and the time suitable for research is too short. It is a big disadvantage for extensive experiments. It is impossible to repeat the experiments in one year of cultivation. It is possible to prepare a sufficient stock of materials beforehand and to prepare the experiments gradually while working with seeds with simulated moisture content. It is possible to utilise the time needed to execute the experiments perfectly and it is no problem to repeat

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them. We meet only the notion of moisture content in the papers by many authors without a clearer definition of the way it was obtained. If the aim of the research is to describe the difference in the physical properties in relation to the changing moisture content of the materials, it will be necessary to define the way the moisture content is obtained. It is also important to know the difference in the physical properties which were found in seeds with biological and simulated moisture contents. This study will enable one to choose the right methodological procedure, extend the time of research and compare the experimental knowledge obtained with that with literature.

MATERIALS

The seeds of chickpea variety KANIVA used in this study were cultivated in 1997 in the fields of the Agricultural and Trade Company RaOS Bojničky, Slovakia.

The following physical properties of the seeds were studied: size, coefficient of restitution, force causing mechanical damage and deformation at this point [8]. Changes of the properties were reviewed in relation to changing moisture content of seeds. Changes of the biological moisture content (76.8-17%) were secured by gradual sampling in the season of July - August. Laboratory simulated moisture (9.7-56.2%) was reached by a moistening device. Sizes of seeds were found by an inductive sensor at the position HBM - W20TK with the accuracy of up to 0.01 mm. Seed mass was registered with an analytical balance, SARTORIUS with the accuracy of up to 0.001 g. The force and the deformation were found by Instron 1112 [8,9]. The coefficient of restitution was determined by calculating the reflection height after loading:

$$\varepsilon = \sqrt{\frac{h_1}{h_2}} \qquad (1)$$

where: ε - coefficient of restitution; h_1 - height of seed rebound from the plate, m; h_2 - height of seed fall, m.

The height of seed rebound was subjectively registered [10]. The size of seeds was measured in three plains, length, width and thickness. Seed density was determined by calculating the equivalent spherical volume [7]. The coefficient of restitution was specified for three plates (wood, steel and concrete). The force causing mechanical damage and deformation at this point was read out from the force - deformation curve at the bioyield point (BP) [1,2,6]. The force applied on seeds was orientated in the plane along its length, width and thickness. All tests with each moisture content were always repeated fifty times.

The moistening device was developed at the Department of Machinery and Production

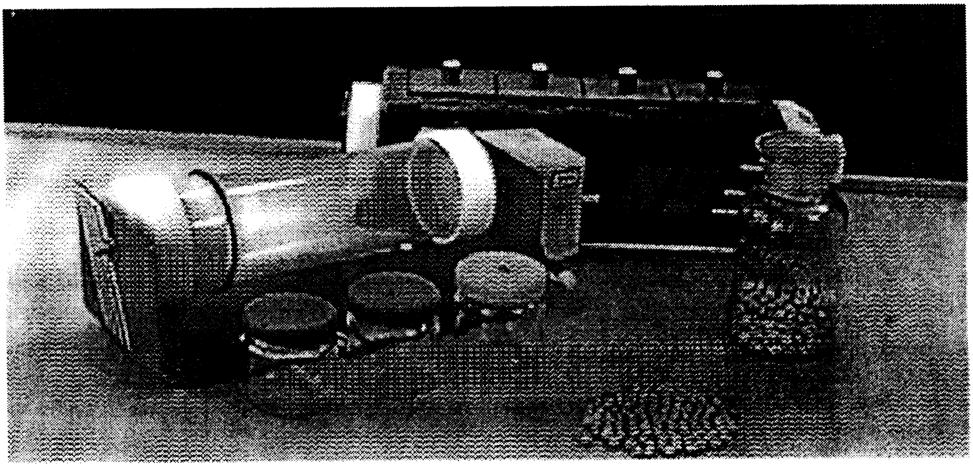

Fig. 1. Moistening device.

Systems of the Slovak University of Agriculture in Nitra (Fig. 1). The principle of moistening reside in supplying the accurate quantity of distilled water to the seed with a known initial moisture content. The samples of seeds with an accurate quantity of water were enclosed in a cylindrical vessel with the moistening device and stored for 24 h in a dark room at the temperature of 6 °C. The moistening device enabled continuous mixing of samples. In this case the phase of mixing was 5 min (slow rotation of horizontally arranged vessels) and 15 min brake phase alternatively. After moistening, the samples were stabilised in the same room for 24 h [3]. The measurement of moisture content was done according to ISO 712.

RESULTS

Physical properties were found by the same methodological procedure with the samples with biological moisture content and of laboratory simulated moisture content.

The size of seeds found at BMC attained higher values than the seeds at SMC. Lower values at BMC of over 70 % were caused by insufficient development of seeds; the plants had not ripened yet and the seeds were still developing. The measurements of seed sizes were executed according to the methodology of three plains perpendicular to each other. The change of the length of chickpea seed found at BMC and at SMC is illustrated in the Fig. 2. The change in the mass of seeds had a similar character. Comparison of the mass of seeds found at BMC and SMC is presented in Fig. 3. The density of seeds was evaluated on the basis of examination of seed size and mass:

$$\rho = \frac{m}{V} \qquad (2)$$

where: ρ - density, kg m^{-3}; m - mass, kg; V - volume of seeds calculated to volume sphere, m^3,

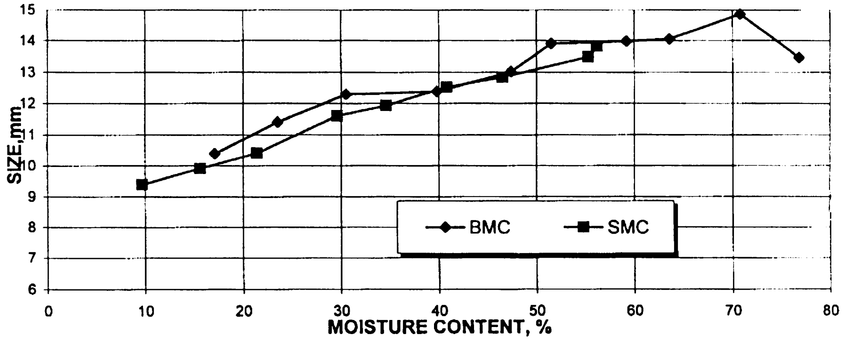

Fig. 2. The length of chickpea seeds as a function of moisture content.

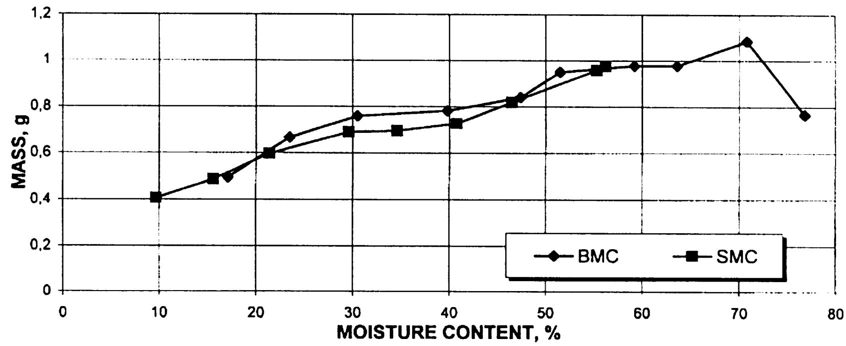

Fig. 3. The mass of chickpea seeds as a function of moisture content.

and

$$d_s = \sqrt[3]{lbh} \tag{3}$$

where: *ds* - average diameter, m; *l* - length, m; *b* - width, m; *h* - thickness of seeds, m.

It is seen from the results presented in Fig. 4 that the density found at SMC is markedly higher than the density at BMC in the full range of moisture contents. It can be seen from the results of experiments which determined the coefficient of restitution that the difference between the values obtained is over 25 % of the total moisture content. These results are confirmed by the fact that the change in the coefficient of restitution depends on the change of moisture content at seed impact on the concrete plate (Fig. 5).

The values of the force and deformation were read from the force - deformation curve at the bioyield point during the detection of the force causing mechanical damage of the seeds. The results of the experiments showed the same characteristics for the three orientations of the effect of the applied force on the seed. The force found at SMC was higher in all the ranges of measurements. On the values of deformation of seeds found at SMC was lower in all the ranges. The results are given in Figs 6 and 7 for illustration.

CONCLUSIONS

Based on the results, we can state that:

- It is not possible to consider the results of the selected physical properties of chickpea seeds obtained at biological moisture content (BMC) and at simulated moisture content (SMC) as identical.
- We must follow the correlation of the relationship of the results obtained at BMC and at SMC during many years of cultivation because these experiments concern biological materials.

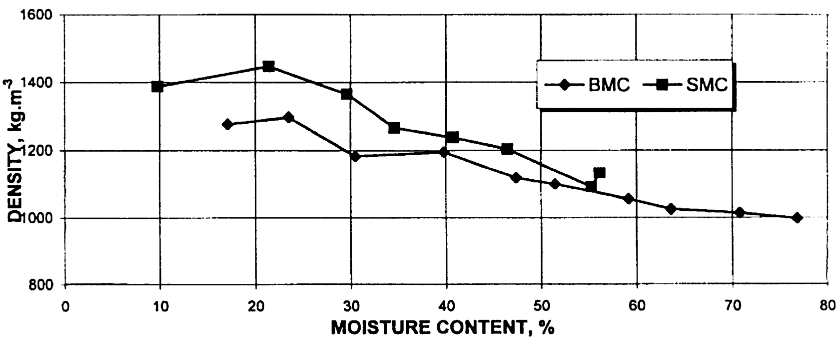

Fig. 4. The density of chickpea seeds as a function of moisture content.

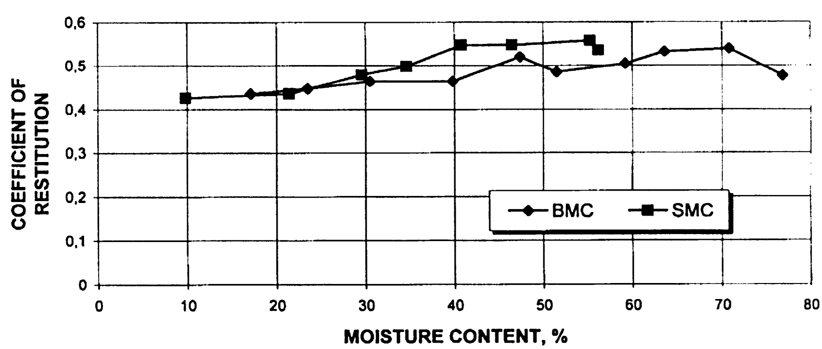

Fig. 5. The coefficient of restitution of chickpea seeds as a function of moisture content (concrete plate).

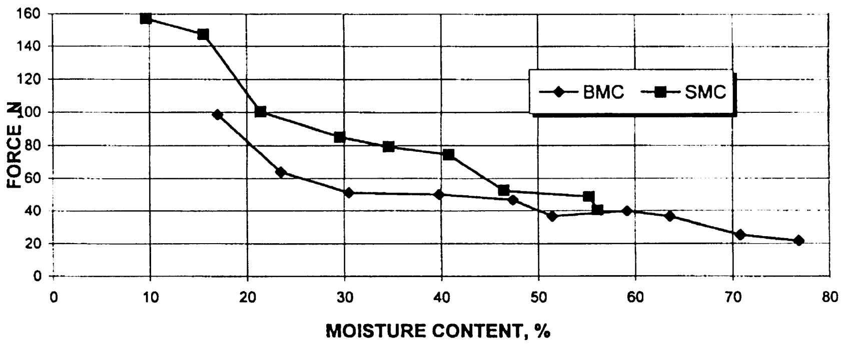

Fig. 6. The force causing mechanical damage of chickpea seeds as a function of moisture content (loading in the direction of the width).

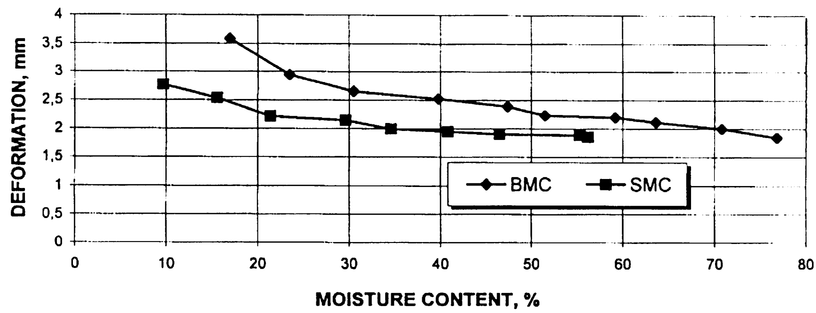

Fig. 7. Deformation of chickpea seeds as a function of moisture content (loading in the direction of the width).

- It is necessary to consider the research objectives and the possibilities available to the researcher, in order to choose experiments at BMC or at SMC while working out methodology of experiments.
- When the results showing relation to the changing seed moisture content are presented it is necessary to define how the moisture content was obtained.

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