# HIGHER TEMPERATURE OF RAPESEEDS AS A FACTOR AFFECTING THEIR MECHANICAL RESISTANCE

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## INTRODUCTION

Rapeseed drying is one of the most important processes of post-harvest handling. Seeds are exposed to high temperature and at the same time are subjected to external forces. These factors, acting together caused kernels damage and, in turn, lower quality of the material for oil production.

The above reason induced the present authors to undertake the study of rapeseed mechanical properties in higher temperature. The above mentioned problem has not been studiet so far, however, physical parameters of rapeseed have already been studied in the context of differentiated moisture content, varietal features, as well as, seed size.

Changes of rapeseed mechanical strength in higher temperature were the aim of the present studies. The influence of moisture content and variety features was also checked. Several factors describing rapeseed mechanical resistance to external loads were calculated, too.

## MATERIALS AND METHODS

The investigations were carried out on three varieties: Jet Neuf, Jupiter and Ceres. Seed came from the crops of 1989 and were specially prepared before investigation in order to achieve a required moisture content. Five moisture levels: 4, 7, 11, 14 and 17% w.b. were chosen. The first level was obtained by drying air dry seeds in a laboratory dryer for two hours in 40°C. Air dry rape taken from the store-room had 7% of moisture.

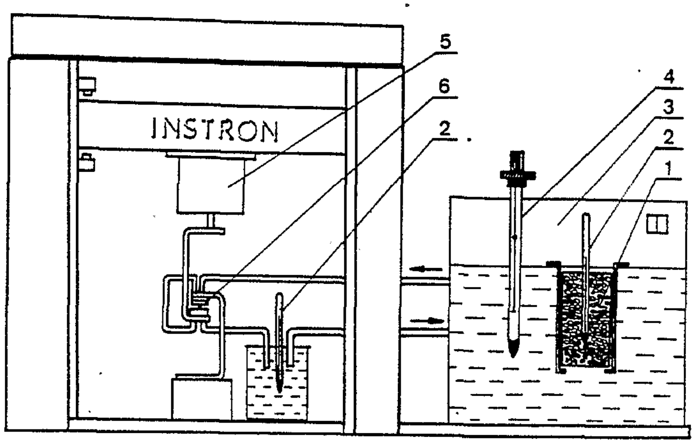


Fig. 1. The heating system conected to the Instron machine:
1- container with seeds, 2- thermometer, 3- thermostat,
4- temperature control, 5- head, 6- heating chamber

The next levels were obtained by wetting in the air-tight bottles. The moisture content was checked before and after each test. Seeds were harvested by hand so that the material had no injures.

Five temperature levels 20, 30, 40, 50 and 60°C were chose, i.e. from room temperature - 20°C, to the temperature of rapeseeds after drying - 60°C. Seeds were heated, short before testing, in air-tight, glass bottles, placed in hot water from the termostate. The same water was used to heat the chamber were seeds were compressed.

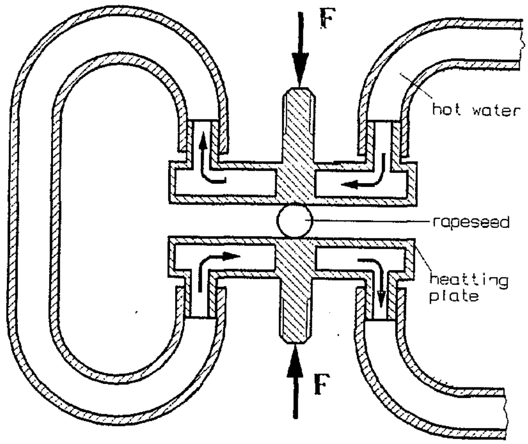


Fig. 2. Compression chamber with a heating plates

The static compression test was conducted in a specially constructed thermal chamber fixed in to the Instron machine model 1253. The chamber consisted of two parallel, heating plates and a wall around them to protect against air movements inside the chamber. The plates were heated by water from the thermostate so the temperature of plates as well as the temperature of rapeseed were equal. The speed of compression was 10mm/min. The data were collected by the computer connected with the testing machine. The force causing damage (force till shell failure), the energy coresponding to it and the modulus of elasticity were calculated for a single kernel.

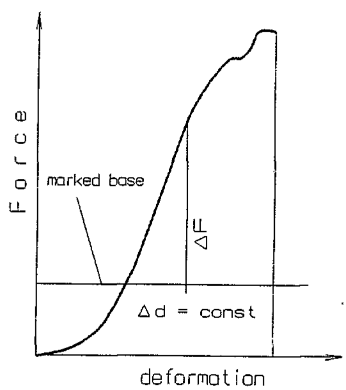


Fig. 3. Typical force-deformation curve and the characteristic value for the modulus of elasticity calculation

The modulus of elasticity was calculated from the linear part of the force-deformation curve (Fig. 3) with a constant increase of deformation, according to the formula:

$$E = \frac{1.061\ (1 - \mu^2)}{\pi} \sqrt{\frac{k^3}{R}} \sqrt{\frac{(\Delta F)^2}{(\Delta d)^3}}$$

where:

| | | |
|---|---|---|
| $\mu$ | - | Poisson's ratio |
| k | - | constant |
| R | -[mm] | radius of curvature |
| $\Delta F$ | -[N] | force in the linear part of force-deformation curve |
| $\Delta d$ | -[mm] | deformation of the seed in linear part of force - deformation curve |

The radius of curvature was set as equal to infinity for the parallel plates. The constant k was assumed as equal to 1.3514 and Poisson's ratio $\mu$ as equal to 0.4.

## RESULTS

The results showed that both moisture content and temperature of seeds influenced seeds mechanical properties.

The damaging force decreased with the increase of the moisture content as well as with the increase of temperature; for the seeds of 4% moisture content it was 16.7 ÷ 15.1 N (for different varieties) at the temperature 20°C, and for the same moisture, but at the temperature of 60°C it was 13.5 ÷ 10.8 N. Considering the influence of moisture content itwas easy to notice that for 17% m.c and temperature 20°C this force was 9.6 ÷ 9 N. The lowest damaging force occured at 60°C and high moisture content (17%) and was 7.5 ÷ 8.3 (for different varieties). The tendency - the dryer seeds, the higher influence both moisture content and temperature was observed (Fig. 4).

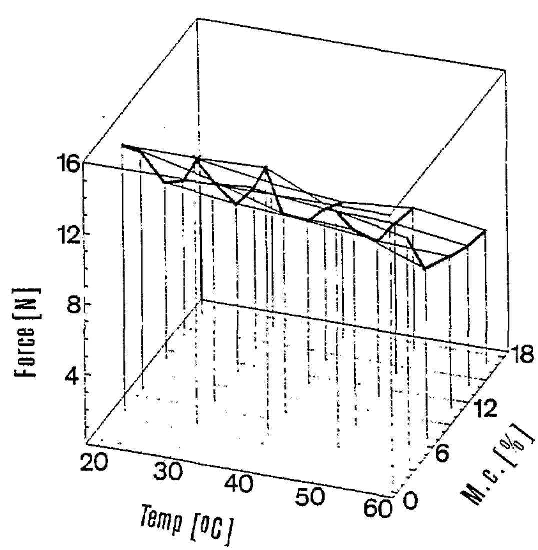


Fig. 4. The influence of moisture content and temperature on the damaging force of rapeseed (variety Ceres).

The energy required for shell failure changed with the change of moisture content and temperature similarly to the damaging force (Fig. 5). The highest damaging energy was observed at 20°C and 4% m.c. and was in the range from 4.18 to 4.0 mJ (depending on the variety). The smallest damaging energy was observed at 60°C and 17% m.c. and it was in the range from 2.27 to 2.84 mJ.

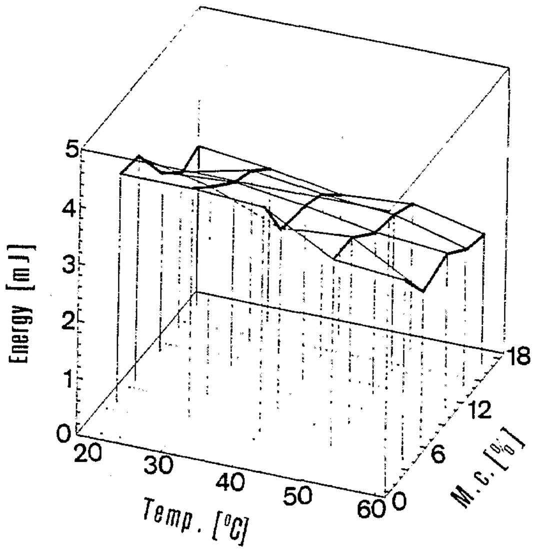


Fig. 5. The influence of moisture content and temperature on the damaging energy of rapeseed (variety Ceres)

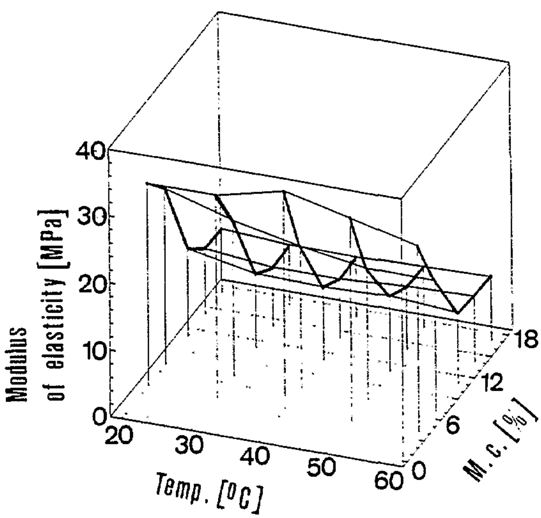


Fig. 6. The influence of moisture content and temperature on the modulus of elasticity of rapeseed (variety Ceres)

A similar tendency as in case of damaging force and damaging energy occured also for the modulus of elasticity (Fig. 6). This parameter varied from 37.4 till 30.1 $N/mm^2$ at the lowest temperature and moisture content and decreased to 8.0 ÷ 9.5 $N/mm^2$ at the highest temperature and moisture content.

Considering the differences between varieties, one could notice that the highest damaging force, energy and modulus of elasticity appeared in the case of Jantar variety, both at high and low level of moisture content and temperature. Nevertheless, the decrease of these parameters was the highest for that variety, too. The lowest values of mechanical parameters mentioned above was observed in the case of Ceres variety.

## CONCLUSIONS

1. The increase of seed temperature and moisture content caused the decrease of damaging force as well as damaging energy and modulus of elasticity.
2. The changeability of damaging force, damaging energy and modulus of elasticity plays a greater role at lower moisture levels; with the increase of seeds moisture this changeability decreases.
3. Jantar variety had the highest values of mechanical parameters and the decrease of these values was the highest in the case of this variety, too.

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