Influence of moisture content on selected physical properties of rape seeds and the processes of cleaning and separation

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Summary. The aim of the research was the determination of change of physical properties of rape seeds during drying process in diverse time-temperature conditions. Kana rape seeds were used for research, at 6% storage moisture content, as well as additionally moistened ones up to 17% postharvest moisture content. The samples were convection-dried at temperature levels (60, 80, 100ºC) for 20 and 40 minutes. After the drying, the physical properties of rape seeds were determined. The results of research showed that high drying temperature or large initial moisture content are not recommended for long storage time. However, the estimate of results showed that rape seeds which are designed for direct processing can be dried at a higher temperature then the temperature applied in present practice.

Key words: rape seeds, drying temperature, physical properties, cleaning, pneumatic separation.

INTRODUCTION

Polish tradition of growing rape seeds, constant growth of its economic significance, which stems from wide possibilities of using oils within the scope of the production of solid food products and liquid plant oils, chemical materials and biofuels for running diesel engines, have caused the necessity for a more versatile and effective use of this valuable plant resource [5, 3, 12]. Any actions aimed at increasing the amount of pressed oil (the so-called extra virgin oil), require seeking new, not yet used in industrial processing of rape seeds, methods for their preparation and initial processing prior to the pressing process [2, 16, 17]. The procedures, which are described as postharvest processing, are the processes of cleaning and drying seeds. These processes influence both the change in physical and technological properties of seeds, increased costs as regards electricity consumption, and the quality of final products [15, 20, 17, 13]. Rape seeds before storing should be cleaned and dried to the moisture content below 7%. Previous research and practice indicated that in seeds with high water content there occur many unfavourable processes negatively influencing further storing and processing [1, 6, 14]. Improper execution of the drying process, especially the use of too high temperatures, leads to changes in physical and chemical properties of rape seeds. As it has been indicated by previous experiments in this scope, seeds of higher moisture content should be dried at low temperatures. High temperatures negatively influence utility and technological values of the resource leading to, among others, decreasing mechanical durability of seeds, at the same time increasing their vulnerability to damage [14, 4, 18].

The aim of this research was to indicate the influence of the moisture content on selected physical properties of Kana variety rape seeds. The scope of this research included the measurement of these parameters for grain with the storing moisture content (W=6%) and seeds additionally moistened to the postharvest moisture content (W=17%). Additionally moistened seeds underwent the process of convection drying in different ranges of time and drying temperatures, then measurements related to defining and assessing selected physical properties of seeds were conducted.

MATERIAL AND METHODS

For the purposes of the research Kana variety rape seeds were used. This variety is characterised by a high degree of oil content, proved high output content of oil, as well as generally good technological quality of this resource. Seeds with the initial moisture content W=6% were additionally moistened to the postharvest moisture content W=17%. In order to additionally moisten seeds to the established moisture content an adequate amount of water was added, which was calculated from the formula (1):

$$Mw = \frac{M_1 - M_0}{100\% - M_1} * m, \qquad (1)$$

where: M_w – mass of water necessary for additional moistening, [g],

M_1 – moisture content of grain after additional moistening, [%],

M_o – initial moisture content of grain, [%],

m – mass of sample, [g], [Lis et al. 1983].

In order to equalise the required moisture content in the total mass, the conditioned samples were stored in hermetic containers in a cooling chamber at a constant temperature approx. 3°C and underwent multiple mixing during the day. Next, the seeds were dried in a laboratory drier at temperatures T=60, 80, 100 and time t=20min and 40min. Control samples constituted seeds of the moisture content 6% and 17% before drying. The seeds were placed on perforated metal sieves, in a thin 0.5cm layer. The drying process was conducted in a laboratory drier with turbo-circulation. After completing the process of seeds drying and cooling, the specific physical properties, i.e.: the moisture content, angle of slide and angle of repose, tapped bulk density and loose bulk density, mass of 1000 seeds and average particle size were defined. All the tests were conducted according to the Polish Norms, in five repetitions (the results were presented as averages).

RESULTS AND DISCUSSION

In order to indicate the range of changes in physical properties which are especially important in further processing, which determines the quality of seeds and their technological value, it is necessary to define selected groups of geometrical and mass properties of the resource [18]. The defined initial parameters (Tab. 1.) were used as the database against which the results achieved during the conducted tests after the processes of drying were compared. The research, conducted according to the established aim and methodology, has indicated high sensibility of rape seeds in relation to varied time periods and drying temperatures. Changes were recorded for all the tested groups of physical properties.

Table 1. Comparison of physical properties of Kana variety rape seeds of moisture content 6% and 17%

Physical properties	Kana – winter rape seeds variety	
Moisture content [%]	6.0	17.0
Angle of slide [°]	16.83	22.48
Angle of repose [°]	21.33	26.77
Loose bulk density [kg·m^{-3}]	631.16	618.84
Tapped bulk density [kg·m^{-3}]	701.23	665.79
Weight of 1000 seeds [kg]	0.00637	0.00711
Average particle dimension [m]	0.00168	0.00188

The above table presents basic physical properties of the tested Kana variety rape seeds with two extreme levels of moisture content. Seeds with lower moisture content (dry) had a smaller angle of slide and angle of repose, as well as average particle size and mass of 1000 seeds. When it comes to mass characteristics, lower values of density (both in tapped bulk density and loose bulk density) were achieved for samples of seeds with moisture content W=17%.

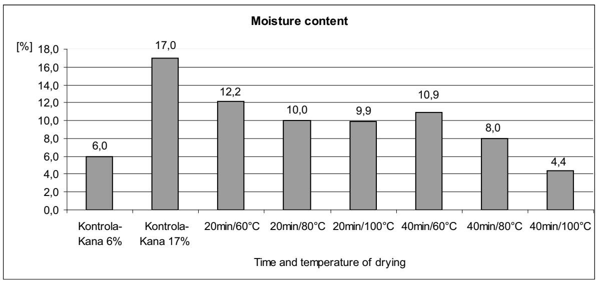

Fig. 1. The range of moisture content changes in the tested seeds, achieved during drying in different ranges of time and temperature

In the general assessment of the quality of seeds which are treated as a processing resource, their moisture content is taken into account, which has a significant influence on storing seeds and their utility for further processing. The range of seed moisture content changes presented in Fig. 1. illustrates the intensity of water loss during the process of seeds drying. From the analysis of the moisture content distribution it results that drying at a temperature of 100ºC and time 40min is unfavourable because the moisture content of seeds decreased far below the require storing moisture content and was only W=4.4%. Differences in the level of values of tapped bulk density and loose bulk density were also recorded. Density of seeds (Fig. 2a) generally increased together with elapsing time and increasing temperature and were within the range from 619.2kg·m^{-3} to 891.7 kg·m^{-3}. Seeds dried at the highest temperature for the longest time recorded an especially significant increase in tapped bulk and loose bulk states. Different drying parameters of specific samples of rape seeds had a significant influence on changes of the angle of slide and the angle of repose. The lowest values of the angle of slide (as compared to the control sample), were achieved for seeds dried in the highest range of time and temperature (40min/100°C). Its value was 15.67° (in relation to the control test 22.48°). Milder drying conditions (e.g. 40min/60°C or 20min/60°C), also influenced the change of values of the angle of slide and repose, however these decreases had a lower range of changes (Fig. 2b.). In the seeds processing industry the mass of one thousand seeds and the average particle size are the main indicators of ripeness of seeds, and at the same time indicators of technological value.

As predicted, these changed together with the change of drying parameters, i.e. the more intensive drying, the lower the values of these properties (Fig. 3a and b).

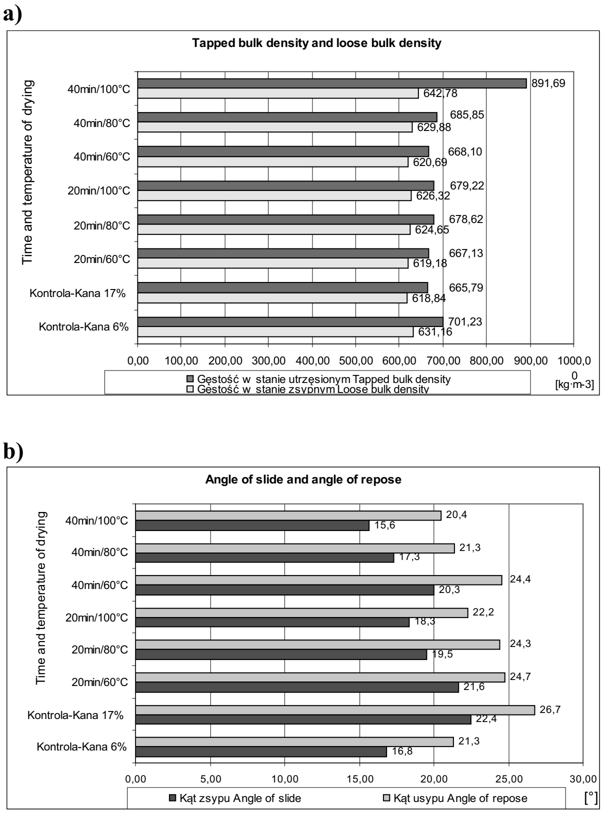

Fig. 2. The range of changes of physical properties: a) tapped bulk density and loose bulk density; b) angle of slide and angle of repose

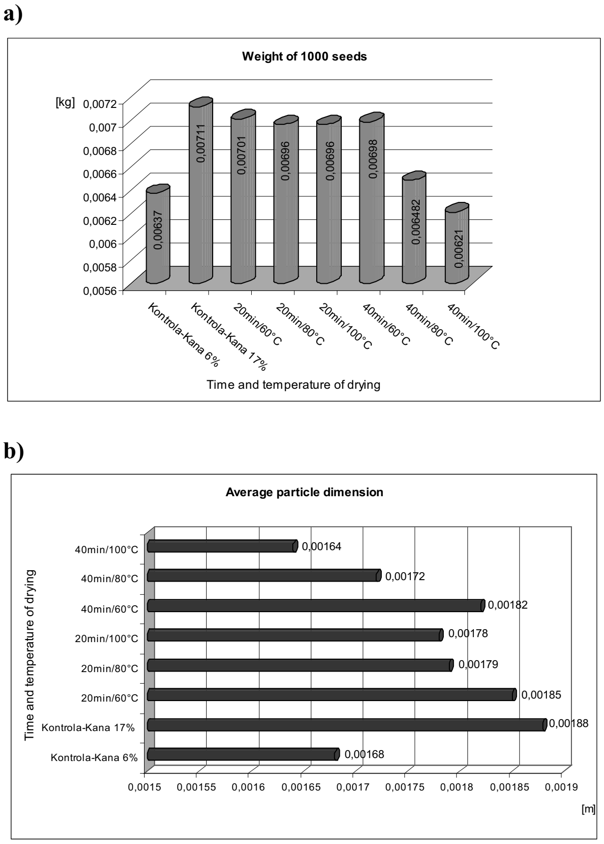

Fig. 3. The range of changes of physical properties: a) weight of 1000 seeds; b) average particle dimension, achieved in diverse time-temperature conditions of drying process

The achieved research results and their analysis explicitly indicate the influence of drying time and temperature on a selected group of physical properties of tested rape seeds. Every change, even in a narrow range, of conditions of the drying process influenced a decrease or increase of particular physical properties of seeds.

The scope of recorded changes, conditioned by transpiration, has led both to favourable and unfavourable influences on further preparation and processing of seeds. The achieved research results constitute a valuable database important both in the process of cleaning and separation, drying and storing seeds, and in further processing related to acquiring oil (cold pressed oil, extraction, rafination, etc.) It should be presumed that drying conditions may also influence the effectiveness of the pressing process and the quality of pressed oil. It should be added that clarification of the above-mentioned relations will be undertaken in the next cycle of research.

CONCLUSIONS

On the basis of the conducted research the following conclusions were formulated:

The conducted research related to the scope of changes of selected groups of physical properties in relation to the moisture content of seeds present a possibility to assess them in the aspect of application of different times and temperatures of rape seeds drying, as well as further preparation and processing.

A very high temperature of drying and long duration of this procedure influence the speed and intensity of drying, as well as significant changes (mostly unfavourable) of the majority of tested physical properties of seeds, and at the same time their technological value.

The research results indicate that in case of seeds with a high harvest moisture content (within the range W=17%), it is necessary to precisely select and apply parameters of the drying process, thanks to which the required storing moisture content (6-7%) will be achieved in an effective and energy-saving way, at the same time maintaining high technological value of the resource.

From the practical point of view and technological requirements of processing it seems that the most favourable drying conditions for moist rape seeds after harvesting require drying time t=40min and temperature T=80°C. These parameters condition an effective decrease in the moisture content of seeds to the required storing value, i.e. ~7%. It should be added that the suggested drying conditions must be additionally adjusted and take into account technical-technological parameters of the applied drying machines.

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WPŁYW WILGOTNOŚCI NA WYBRANE WŁAŚCIWOŚCI FIZYCZNE NASION RZEPAKU ORAZ PROCES CZYSZCZENIA I SEPARACJI

Streszczenie. Celem przeprowadzonych badań było określenie zmian właściwości fizycznych nasion rzepaku w zależności od wilgotności i zastosowanych warunków procesu suszenia (zróżnicowany czas i temperatura). Do badań wykorzystano nasiona rzepaku odmiany Kana o wilgotności przechowalniczej 6% oraz dowilżone nasiona tej odmiany do wilgotności pozbiorowej 17%. Próbki poddano suszeniu konwekcyjnemu w temperaturach 60, 80 i 100°C oraz czasie 20 i 40min. Po procesie suszenia określono właściwości fizyczne. Uzyskane wyniki badań wskazują, że wysoka temperatura suszenia oraz duża wilgotność początkowa wpływają niekorzystnie na właściwości fizyko-mechaniczne nasion rzepaku powodując w większości przypadków ich znaczące pogorszenie, co ma istotne znaczenie w przypadku dłuższego przechowywania. Ma to też istotny wpływ na proces separacji pneumatycznej nasion. Ocena wyników badań wskazuje, że nasiona rzepaku przeznaczone do bezpośredniego przerobu mogą być suszone w nieco wyższych, od stosowanych w praktyce temperaturach.

Słowa kluczowe: nasiona rzepaku, temperatura suszenia, właściwości fizyczne, czyszczenie i separacja pneumatyczna.