Effect of Storage Temperature on Rapeseed Quality

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Summary

The objective of this paper was to determine the influence of storage conditions on the quality of seeds in rapeseed cultivar Bristol and hybrid Triangl, namely on the oil and free fatty acids content, which are the two most important rapeseed quality parameters. The rapeseed seeds were stored in two conditions: in storage facility with controlled atmosphere (with temperature of 10 °C and relative air moisture approximately 70%) and in storage facility without atmosphere control (where the air temperature and moisture varied). During a nine-month storing period, the samples' mass was monitored monthly while oil content, free fatty acids (FFA) content and seed moisture were determined before and after storing.

Storing in conditions without atmosphere control showed that the samples' mass was increasing during the first four months, in the following three months it was decreasing, and then stagnated until the end of the storing period. Samples stored in controlled atmosphere showed variations in mass, with minor oscillations during the whole storing period, which resulted in lower FFA content in comparison with the samples stored in facilities without atmosphere control. The oil content after storing in both facilities decreased, and FFA content rose in all samples. In conclusion; storing in controlled atmosphere gave better results in terms of rapeseed quality.

Key words

rapeseed, storing, oil content, free fatty acids content

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Introduction

Rape (*Brassica napus ssp. Oleifera*) belongs to the family of cabbage vegetables (*Brassicaceae*) and its cultivation goes as far back as 4000 years. This culture is grown primarily because of its seeds use for oil production. The oil content in rapeseeds ranges between 35 and 45 percent. The yield of rapeseed is about three tons per hectare, which allows the production of around 1200 liters of oil, depending on cultivar i.e., on rapeseeds' oil content (Krička et al., 2004).

The oil is used in human diet and for industrial purposes (biodiesel fuel, detersives, soap, etc.) It is obtained through cold and hot pressing treatments, with rape cake or crushed seed as by-products. Rape cake and crushed seed are used for animal feed as a component in various feed mixtures because of their high protein content (about 30%) and favorable amino acid composition. Recently, researches have been carried out to examine the potential use of rape cake for energy production (Krička et al., 2002).

In previous periods, rape was not a culture of preference in agricultural production due to its high concentration of erucic acids and glucosinolate (Patterson, 1989). These two ingredients result with some undesirable characteristics of the rapeseed products. Erucic acid is a mono unsaturated fatty acid which gives a sour flavor to oil, and in high quantities it can also be toxic for human health. Glucosinolates that remain in the cake after oil extraction are goitrogen substances and at the same time are subject to enzymatic hydrolysis, which results in various toxic products. For the same reason, both crushed seeds and cake, although protein rich, are added in very low percentages to the feed mixtures because animals tend to reject such food and consumers found the flavor of these products (e.g., eggs) rather distasteful (Food Standards, Australia New Zealand, 2003).

Various improvement procedures enabled creation of new varieties with glucosinolate content below 30 μmol /g, and improved fatty acids composition. These varieties contain less than 2% of erucic acids, more than 80% of oleic acid, and less than 2.5% of linolenic acid. Such cultivars and their oils are referred to as canola varieties and oils ("Canadian oil, low acid"). Oleic acid is an unsaturated fatty acid, and its use in nutrition is recommended because it lowers the level of low density lipoproteins (LDL). The food rich in saturated fats increases the level of LDL that is the medium for cholesterol amassing in blood vessels (DeBonte et al., US Patent, 2003). As a result of this change in fatty acid composition the quality of the rapeseed oils can match that of other vegetable oils.

When rapeseed is stored, it is essential to preserve the quality of seeds. The main quality parameters are oils and free fatty acids contents. The content of free fatty acids in rapeseed is usually between 0.5% and 1.5%, and the highest quantity allowed for food oil production is 2%, and 5% for biodiesel fuel production (Krička et al., 2007). In the period between harvesting and storing it is essential to dry rapeseed down to 6-8% moisture content. The moisture content is an important factor because water is a medium for development of microorganisms that may cause seed corruption and it also affects the enzyme activity. It can lead to oil hydrolysis, which results in decomposition of triglycerides and release of fatty acids. A higher content of free fatty acids in the seeds is not acceptable because it gives ill flavor to oil and in order to avoid this, a pre-treatment that eliminates free fatty acids is necessary. This treatment gives lower oil yields and makes the production more costly. The degradation of seed oil quality during the storing period may lead to oxidation as well, which may be set off by various factors, such as air, light, moisture, temperature, catalysis and enzymes (Patterson, 1989). In order to preserve the good quality of the seeds the storing temperature should be maintained at 10 to 12 °C maximum (Krička et al., 2004.).

The objective of this paper is to determine the influence of the storing methods on quality of rapeseed of cultivar Bristol and hybrid Triangl by monitoring the variations in oil and fatty acid contents (FFA).

Materials and methods

Variety Bristol and hybrid Triangl, which were cultivated in the region of Western Slavonia, were used for investigation during the vegetation year 2006/2007.

The seeds of these cultivars were dried in a lab dryer at three different temperatures (50 °C, 60 °C and 70 °C) with one control sample that was dried in natural conditions. On the basis of temperature parameters the samples were sorted for storing. After drying treatment the contents of water, oils and free fatty acids were determined. The water content was determined by ISO/R 665 method, oil content by ISO/R 659 method, and FFA content by ISO 729 method.

After determining the initial composition of the rapeseeds, they were stored in a form of 100-gram samples. The storing was conducted in two ways: in a storage facility with moisture and temperature control (where relative air humidity was 70% and temperature 10.0 °C) and in storage facility without atmosphere control, i.e., in environment-like conditions (where humidity and temperature were not constant). The storing was monitored over a period of nine months, and sample mass was observed on a monthly basis, while atmosphere condition was under constant monitoring by thermometer and psychrometer. After nine months of storing, the contents of oil and FFA were determined again, using the same methods as before storing.

Results and discussion

Just before the beginning of storing the rapeseeds were dried from the initial moisture levels, which in cultivar Bristol was 16.7% and in hybrid Triangl 15.6%, down to mean moisture level of 6.1%.

During the storing period, the rapeseeds' mass was measured monthly both in the controlled and uncontrolled atmosphere conditions.

The changes in the sample mass in storing facility without atmosphere control are shown in Figures 1 and 2

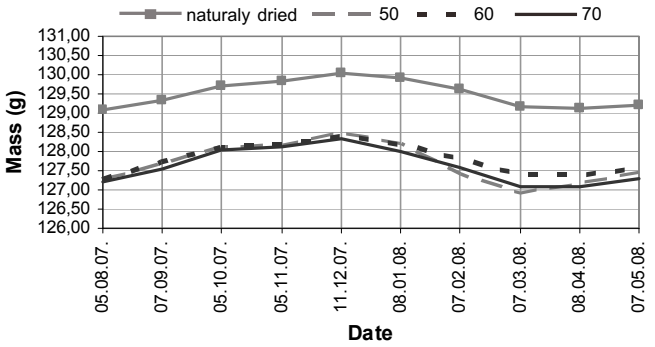

Figure 1. Changes in sample mass of cultivar Bristol in storing facility without atmosphere control

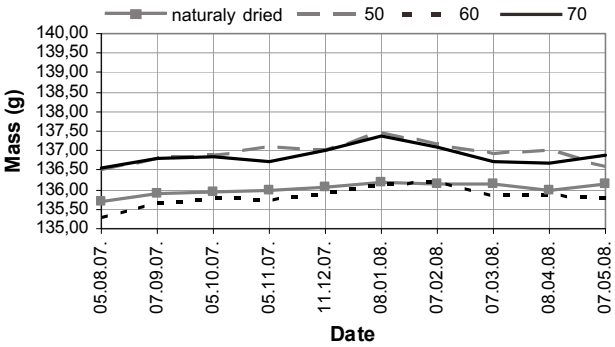

Figure 3. Changes in sample mass of cultivare Bristol in controlled storing atmosphere

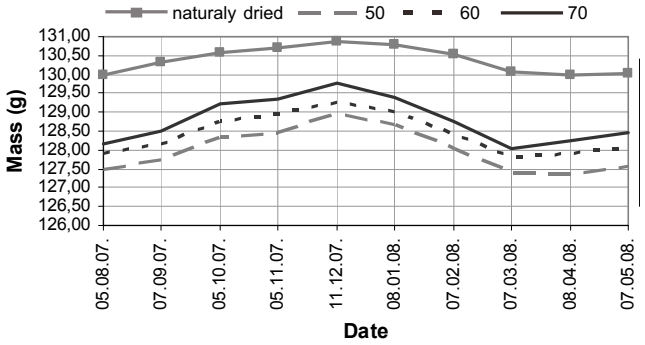

Figure 2. Changes in sample mass of hybrid Triangl in storing without atmosphere control

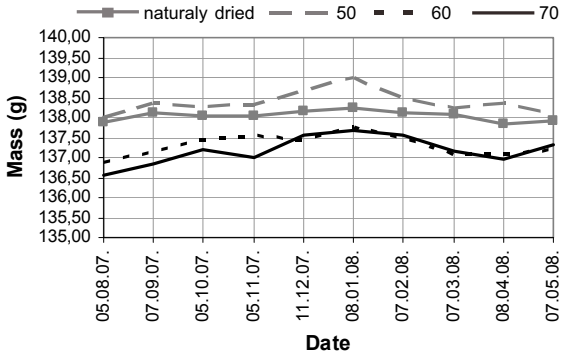

Figure 4. Changes in sample mass of hybrid Triangle in controlled storing atmosphere

Figures 1 and 2 show that sample mass increased during the first four months, which can be explained by the fact that the rapeseeds absorbed the water from the environment. In the following three months of storage, the mass decreased due to air humidity lowering and temperature rising. In the last two months sample mass was almost unvaried, and it could be noted that same changes were observed in both cultivars. It could also be observed that the smallest variations were recorded in the naturally dried samples.

Figures 3 and 4 show the changes in sample mass in controlled storing atmosphere.

The samples stored in controlled atmosphere showed smaller mass oscillations during the whole storing period. It can be noticed that at least two changes in mass were observed in the naturally dried samples and in the samples dried in uncontrolled atmosphere, while the largest oscillations were observed in the samples dried at 70 °C.

Further, oil and free fatty acids contents before and after storing are also shown in the Figures 5 to 10, and the obtained results are expressed when moisture content was 7%.

Oil content before and after storing in atmosphere without control is given in Figures 5 and 6.

On the basis of the Figures 5 and 6 it can be determined that in both cultivars the oil content dropped after the storing. The oil content decreased by average 3.13% in cultivar Bristol and 1.65% in hybrid Triangl. It can also be noticed that

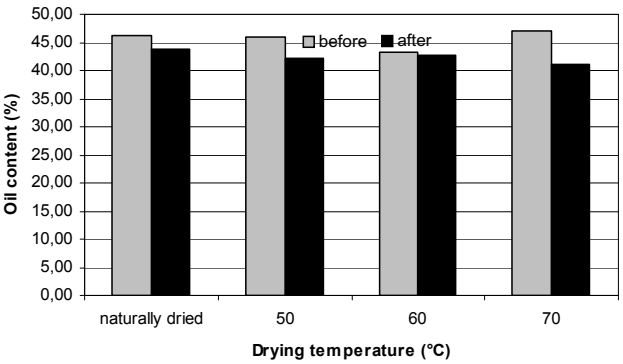

Figure 5. Oil content in cultivar Bristol before and after storing in uncontrolled atmosphere

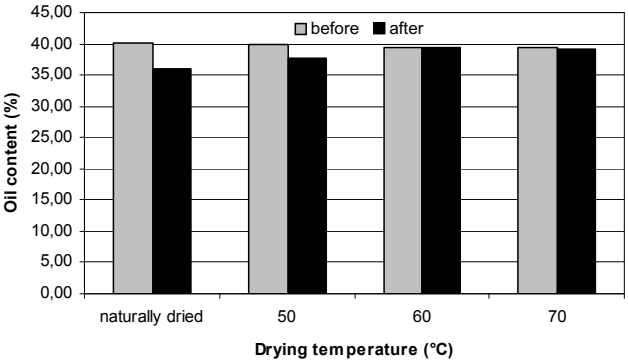

Figure 6. Oil content in hybrid Triangl before and after storing in uncontrolled atmosphere

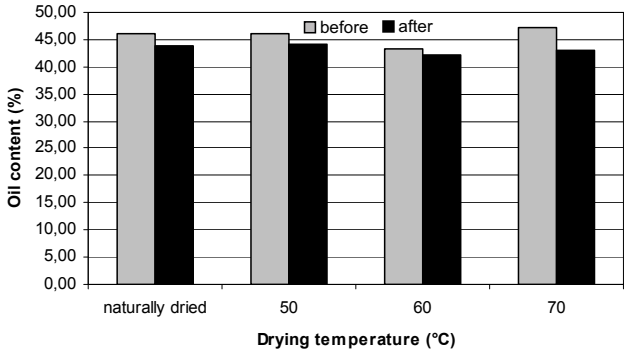

Figure 7. Oil content in rapeseed of cultivar Bristol before and after storing in controlled atmosphere

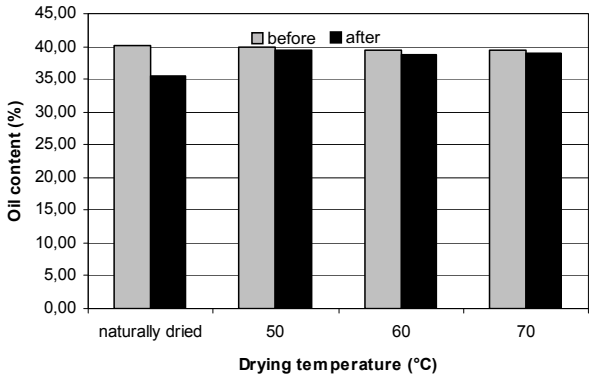

Figure 8. Oil content in rapeseed of hybrid Triangl before and after storing in controlled atmosphere

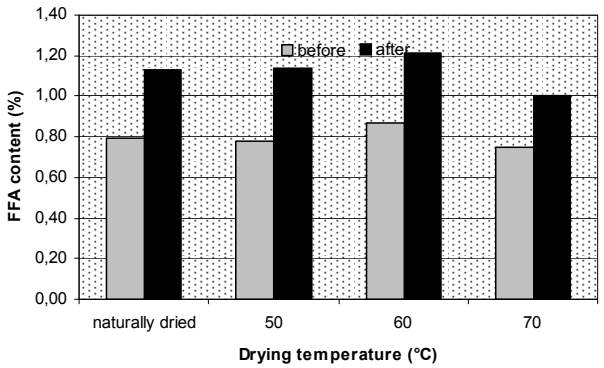

Figure 9. FFA content in 'Bristol' rapeseed before and after storing without atmosphere control

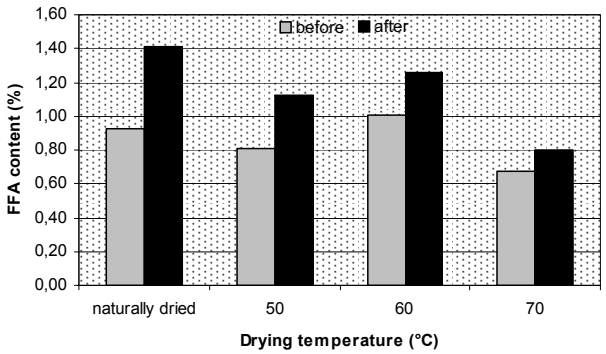

Figure 10. FFA content in 'Triangl' rapeseed before and after storing without atmosphere control

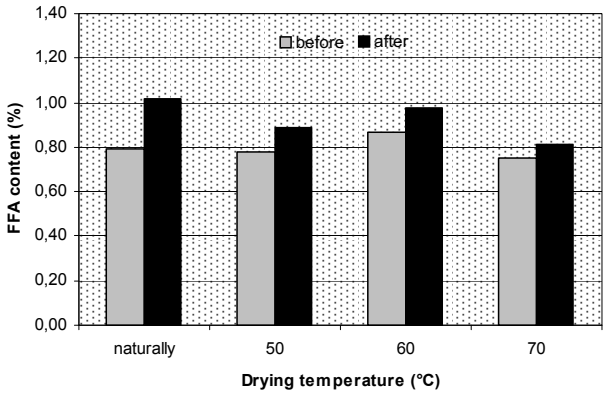

Figure 11. FFA content in rapeseed of cultivar Bristol before and after storing with atmosphere control

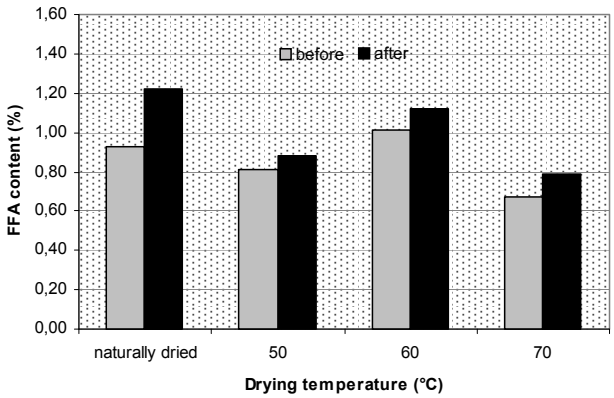

Figure 12. FFA content in rapeseed of hybrid 'Triangl' before and after storing with atmosphere control

the oil content after storing in atmosphere without control in hybrid Triangl dried at 60 °C remained almost unvaried.

Figures 7 and 8 show the oil content and FFA content before and after storing in controlled atmosphere.

The results obtained in the facility with atmosphere control are somewhat better, thus the oil content in cultivar Bristol decreased in average by 2.38%, and in hybrid Triangl by 1.59%. It is evident that in hybrid Triangl dried at 60 °C, as in the storing facility with non-controlled atmosphere, the oil content after storing remained almost unvaried.

The rapeseed's oil content before storing was within the average values, i.e., between 39.36% (which was observed in 'Triangl' sample dried at 70 °C) and 47.12% (observed in the 'Bristol' sample dried at 70°C). After storing in non-controlled atmosphere the oil content was between 36.12% (naturally dried 'Triangl' sample) and 43.88% (naturally dried 'Bristol' sample). After storing in controlled atmosphere conditions the lowest oil content was found in the naturally dried 'Triangl' sample and it was 35.51%, while the highest oil content, of 44.09%, was found in the 'Bristol' sample dried at 50 °C.

The Figures 9 and 10 show the FFA content in rapeseed before and after storing in uncontrolled atmosphere conditions.

It is evident that after storing in uncontrolled atmosphere conditions the FFA content was increased in all samples, and especially in the hybrid 'Triangl' which was dried in natural way, where it increased by 0.48%. The smallest increase in the storing conditions without atmosphere control was observed in the 'Triangl' sample, which was dried at 70 °C. In average, the FFA content in both cultivars was increased by 0.31%.

Although the storing in conditions with atmosphere control also resulted in increasing of FFA, this increase was smaller than the one found in storing without atmosphere control. Thus, the average FFA content in both cultivars increased by 0.14%. The lowest increase was observed in the Bristol sample dried at 70 °C and it was 0.06%.

The FFA content before storing was within the average values and mainly did not exceed 1.0%, with exception of one sample ('Triangl' dried at 60 °C) where it was 1.01%. The lowest FFA content before storing was found in the 'Triang'l sample dried at 70'°C. After storing in either method the FFA content did not exceed the allowed maximum of 2'%. The highest FFA content was found in the naturally dried sample of 'Triangl' stored without atmosphere control, and it was 1.41%. The lowest value was found after storing with controlled atmosphere in the 'Triangl' sample dried at 70 °C, where it was 0.79%.

The research showed that total FFA content after storing without atmosphere control was higher in all samples compared to storing with atmosphere control.

Such results were also found in some previous investigations of the rapeseed cultivars. In 2004, Krička determined a decrease in oil content and an increase in FFA content after storing either in conditions with or without atmosphere control. A similar increase of FFA was observed by Banks as well in 1998.

The reduction in oil content and increase in FFA content in rapeseed most often occur in damaged seeds, and the reasons may lie in hydrolysis, oxidation and oil spill on other surfaces (Sathya et al., 2006). Hydrolysis happens because of moisture in seeds and moisture in the environment. In this process triglycerides are decomposed and fatty acids are released. Oxidation may occur in multiple simultaneous processes and leads to multiple products that results in oil degradation (Patterson, 1989).

In this research, the hybrid 'Triangl', especially the sample dried at 60 °C showed better results when stored without atmosphere control, where the oil content decreased by only 0.14% and the FFA content increased 0.25%. Further, better results after storing with atmosphere control were also found in hybrid 'Triangl'. However, the sample was dried at 50 °C. The oil content in rapeseed of the same cultivar decreased by 0.39%, while the free fatty acid content increased by only 0.07%.

Conclusions

On the basis of monitoring the rapeseed quality parameters in two rapeseed cultivars, cultivar Bristol and hybrid Triangl, during the storage without and with atmosphere control, the following conclusions can be drawn:

1. in samples stored in uncontrolled atmosphere the mass increased during the first four months, it decreased during following three months, and stagnated until the end of the storing period;
2. the mass in samples stored in controlled atmosphere showed minor oscillations during the whole storing period;
3. the mass in naturally dried samples in storing in either ways showed the smallest oscillations during the whole storing period.
4. the oil content in rapeseeds was decreased during the storing, regardless of the storing method, but the decrease was lower in the rapeseeds stored with atmosphere control;
5. the free fatty acid content increased regardless of the storing conditions, but it was observed that the increase was lower in the controlled atmosphere;
6. higher quality of rapeseed is achieved by storing in atmosphere control conditions.

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