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EFFECT OF STORING PERIOD ON THE QUALITY OF PHYSICAL AND CHEMICAL PARAMETERS OF THE INDUSTRIAL WINTER RAPE SEEDS

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Summary. The physical and chemical parameters of winter rape seeds stored under laboratory conditions for up to three years were analyzed. Seed humidity and crude fat were assessed in seeds as well as the chlorophyll content and kinetic viscosity measured for the oil. As a result of the seeds storage process the tendency of the decrease of crude fat in seeds was observed as well as in chlorophyll content in the pressed oil. In general, all the analyzed seed and oil quality parameters were contained within the permitted range of standards making the examined seeds a valuable material for different industrial branches.

Key words: rape seeds, seeds humidity, crude oil, chlorophyll, kinetic viscosity

INTRODUCTION

Seeds of oilseed plants and mainly rape seeds are still used for the production of edible oils. During the last years both in Poland as in the world the increase of interest in this plant is observed. Apart from utilization of the rape oil as a semi-finished foodstuff or chemical [Rojek *et al.* 2010], usage as a material for the production of bio-fuels for high-pressure engines becomes more popular [Krygier *et al*. 1995a; Bendioli et al.. 2003; Szlachta, 2002; Wawrzosek *et al.* 2006; Kachel-Jakubowska *et al.* 2010] as well as usage of oil as a heat source for drying the grains [Rosiński *et al.* 2006]. In The National Catalogue of Agricultural Plant Varieties many rape plant varieties originated from Poland as well as from France or Germany different from crude oil are registered [Heimann, 2005; Wcisło, 2006; Dz.U.UE, 2010]. In Poland cultivation of the low eruic acid and glucozynolates is recommended as these varieties are characterized by a low level of anti-nutritional components [Muśnicki, 2003]. The quality of rape oil is dependent on their physico-chemical parameters highly affected by the plant variety (genetic factor determining chemical content) and to the climatic and soil conditions where plants are cultivated. Seed humidity [Janowicz, 2004] as well as fat content and composition have the crucial impact on physical and technological properties of the seeds as the main cause of deterioration of seed quality during their storage. The presence of chlorophyll in the rape seeds is undesirable for the reason of difficulties with its removal and obtaining high quality oil and its byproducts. On the basis of long-term research, Daun [1987] found that the chlorophyll content is related mainly to the variety and the cropping year. Seeds containing below 24 mg/kg of chlorophyll were considered as a high quality material. In the case of fuel industry oil should be characterized by a relatively high thermal stability and viscosity. Kinetic viscosity is straightforwardly related to the lipid composition and properties [Wcisło, 2008] characteristic for lipids in all of their physical states as a result of intermolecular interactions. According to Niewiadomski [1983] and Ojczyk [1996] viscosity of non eruic acid oils is somehow higher than that of refined oil. Kinetic viscosity of traditional rape oil at the temperature of 20°C is 90 mPa·s and is relatively high compared to the viscosity of soy and olive oil which are 60 mPa·s and 77 mPa·s, respectively. Kinetic viscosity is highly temperature-dependent and for non eruic acid rape seeds amounts to 17 mPa·s at the temperature of 50°C. For some varieties kinetic viscosity at 30°C amounts to about 65 mPa·s while at 60°C is at the level of about 24 mPa·s [Tremazi *et al.* 1965].

The aim of the presented work was the determination of the physical and chemical parameters of rape seeds stored up to three years under laboratory conditions and of the quality of oils pressed from these seeds in order to estimate their usability in certain industrial branches. The estimations were based on the measurements of seed humidity, seed crude fat content, chlorophyll content in oil and on the measurements of oil kinetic viscosity.

MATERIALS AND METHODS

Experimental material consisted of 0.5 kg samples of the industrial rape seeds from the Oil Plant in Bodaczów, taken randomly from the bulk raw material supplied by 17 different contractors. All the samples were from the Lublin area (South-East Poland) and consisted of a mixture of different varieties collected by individual suppliers. Seeds were collected according to PN-EN ISO 542/1997 standard and stored under laboratory conditions at the temperature between 19- 22°C and humidity between 60-70%. Seed material consisted of the variety of mixed rape species. It was not possible to find any dependence between the certain varieties of the seeds and contractors for the reason that the Oil Plants do not maintain a register of supplied varieties and that the seeds from different varieties were mixed both during collection by the producers and during seed purchase. During the time of seed collection and experiments Bodaczów Oil Plants were purchasing seeds from the following winter seeds: Bazyl, Bojan, Californium, Cabriolet, Casoar, Kaszub, Lisek and Libomir. They are cultivars registered in The National Catalogue of Agricultural Plant Varieties [Dz.U.UE, 2010]. Every seed batch was represented by two independent samples provided with labels indicating the source of the seeds.

Experiments included the analysis of physical and chemical parameters of the rape seeds as well as oil pressed from the seeds stored for a period up to three years. Seed samples were marked with numbers 1, 2 or 3 for the storing period of one, two and three years, respectively

Humidity and crude fat of the rape seeds (in %) was determined by means of Omega 10 UV-Vis-NIR Bruins Analyser equipped in 10 interference filters for organic substances. The instrument was provided with internal standard for the rape seeds. The obtained value was the arithmetic mean from 3 independent measurements under condition that the admissible error was not bigger than 0.5% of the measured value.

Chlorophylls *a* and *b* were determined spectrophotometrically in the freshly pressed oil using a double-beam Varian Model Cary 300 Bio spectrophotometer. Samples of oils were diluted 5x in acetone and the spectrum measured between 350 and 700 nm. Concentrations of chlorophylls a (c_a) and b (c_b) and total carotenoids (c_x) in µg/ml were calculated as follows

$$c_a(\mu g/ml) = 11.24A_{661.6} - 2.04A_{644.8}$$

$$c_b(\mu g/ml) = 20.13A_{644.8} - 4.19A_{661.6}$$

$$c_{car}(\mu g/ml) = \frac{(1000A_{470} - 1.9c_a - 63.14c_b)}{214}$$ [Lichtenthaler and Buschmann, 2001]

Rape oil was pressed on a laboratory pressing stand using a HYBREN 6 worm extruder equipped with micrometric mesh strainers. The process of pressing began after stabilization of the press temperature. After pressing of c.a. 1.5 kg of raw material the temperature of extruder reached 70°C. The temperature was measured with TP6 laser pyrometer. The oil was stored at 5°C until used for analysis.

Kinematic viscosity values of oils were determined by using Brookfield RVDV II digital viscosimeter. The measurements were performed at constant temperature of 24.2 °C and the speed of 100 rpm using an A-21 spindle. Measurements were taken after 1 min of stabilised process. The admissible error of the method was 0.5 mPa×s

Statistical analysis consisted in the designation of basic statistical parameters such as mean values, standard deviations and correlation matrices. Calculations were done by using Statsoft Statistica 6.0 program.

RESULTS AND DISCUSSION

Fig. 1. shows the distribution of the seed humidity after storing the seeds for 1,2 and 3 years, respectively. For all the storage years most samples were characterized by optimal humidity ranging between 6 and 8.5% which is considered secure for storing the seeds for longer periods without loses, under condition that the seeds are mature, healthy, clean, having natural color, having the seed covers undamaged and not under the process of sprouting [Niewiadomski, 1983; Janowicz, 2004].

The statistical analysis tests showed statistically significant differences in the seed humidity stored for two years in comparison to seeds stored for one or three years. It also found no statistical differences between the seeds in groups stored for one and three years.

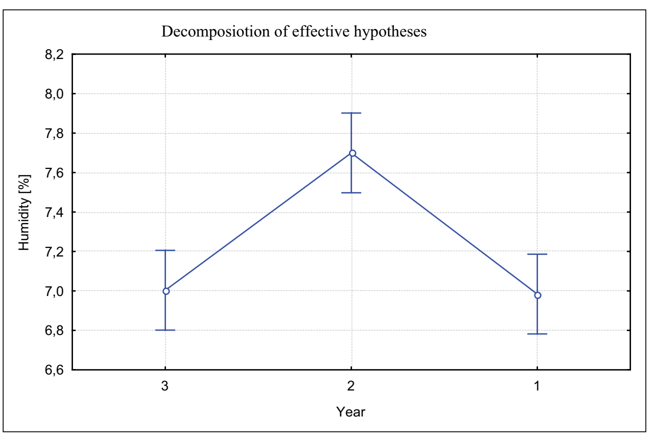

Fig. 1. Humidity of rape seeds stored for up to three years.

The seed material for the oil production in the Oil Plant in Bodaczów contained between 41.1 and 45% of d.m. of crude fat.

The results of Appelqvist [1972] show that storing time of the good quality rape seeds having the humidity at the level of about 7% can be as long as two to three years, without any change in their humidity or fat content.

The results of statistical analysis of the influence of the storing time (between one and three years) on the content of crude fat are shown in Fig. 2. Although no statistical differences were shown between the amples from particular groups, a tendency of the crude fat content's decrease can be observed for the seeds stored for three years.

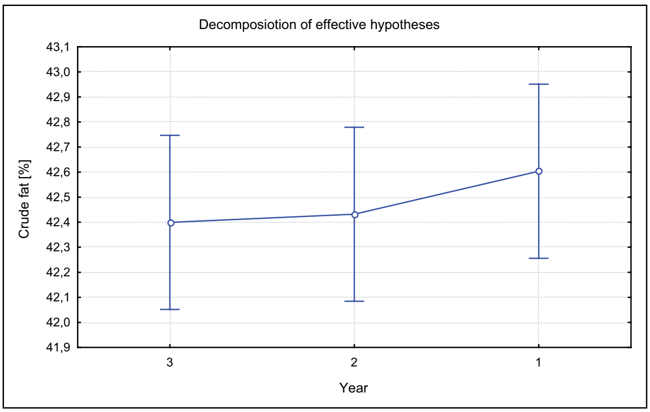

Fig. 2. Crude fat in rape seeds stored for up to three years.

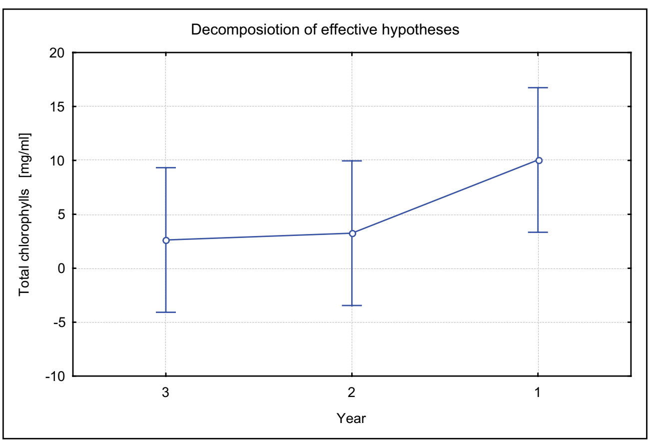

Fig.3. Chlorophyll content (sum of chlorophylls *a* and *b*)
of the rape oil pressed from seeds stored for up to three years.

Fig. 3. shows the total chlorophyll content in the rape seed oil. The samples were characterized by a varying amounts of chlorophylls (from 0.63 to 7.5 mg/ml of oil). On the basis of the data the decrease in chlorophylls was observed upon prolonged storage time (in years) although no statistical differences were observed. Such a tendency is a good information for food industry where

the smallest possible contents of chlorophylls are required due to taste and aesthetic advantages of oil depleted from chlorophylls. The cause of such a phenomenon may be not only the process of storing the material under proper conditions but also suitable seed variety or the cropping method [Tys et al., 2002; Kachel-Jakubowska, 2008].

The examined oils were characterized by similar kinetic viscosity (from 54 to 64 mPa·s), which did not differ statistically ($p \geq 0.05$). The results obtained from the samples stored for longer period showed higher multiplicity of data, caused most probably by the variety of seed stock. Statistical analysis did not show differences between samples from different years (Fig. 4.). The rape oil demonstrates 20-fold higher viscosity as compared to heating oil. This problem, however, in oil burners for boilers can be solved by application of special constructions [Jóźwiak *et al.* 2006].

Viscosity of rape oil differs significantly from this parameter for diesel fuel oil and at the temperature of 40°C is c.a twelve-fold higher, rendering impossible the proper functioning of the engines. This characteristic property forced the invention of double-fuel system eliminating some of disadvantageous phenomena arising during fuel combustion [Dzieniszewski, 2006].

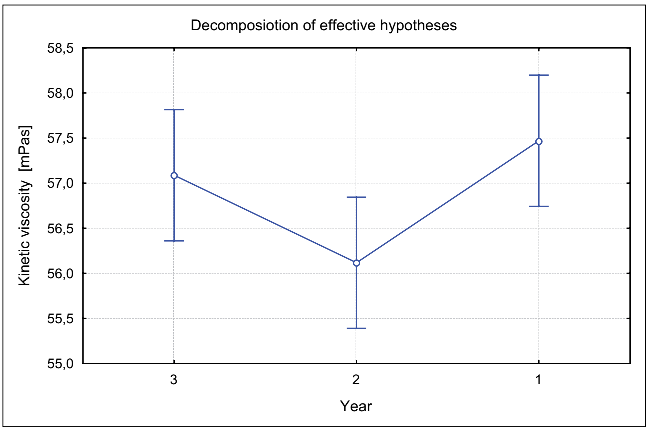

Fig.4. Kinetic viscosity of the oils pressed form the rape seeds stored for up to three years.

SUMMARY AND CONCLUSIONS

The conducted survey and the data analysis show that it is possible to determine the physico-chemical parameters of the rape seeds and the pressed oils in order to evaluate their usability in further industrial processing. The process of storing the material is the most basic element of post-cropping treatment, during which the decrease in the material quality can occur, mainly caused by the excessive humidity. Cleaned, mature rape seeds containing between 6 and 8 % of water can be stored without the risk of severe losses. The crucial problem is therefore maintaining the relative air humidity in storage rooms at the level between 30 and 70% [Janowicz, 2004].

1. The conducted experiments showed that the storage period is statistically influencing the industrial quality of seed humidity which renders a variable initial humidity of seed material supplied by different contractors in a definite year.

2. Of advantage is the decrease of chlorophyll content in oils obtained from the seeds stored for two or three years, which improves the quality of material although it seems to be statistically insignificant.
3. The basic quality parameters of the rape seeds stored under laboratory conditions assessed in this study stayed within the permitted by oil and chemical industry technical standards ranges. This can therefore indicate the favorable selection of varieties as well as good cultivation and cropping technologies.
4. The kinetic viscosity measured for the oils may be of interest for the producers of chemicals mainly because the storage period does not influence this parameter.
5. Although the rape seeds stored for longer periods proved to be useful for industrial purposes, the producers should decide whether the storing of seed material would be profitable considering the cost of storage.

REFERENCES

Abromovič, H., Klofutar, C. 1998. *A*cta. Chim. Slov, .45(1), 69.

Appelqvist L., Lööf B. 1972. Post – harvest handling and storage of rapeseed. In: Appelqvist L., Ohlson R.: Rapeseed. Elsevier, Amsterdam.

Bondioli P., Gasparoli A., Della Bella L., Tagliabauue S.. 2003. Biodisel stability under commercial storage conditions over one year. Eur. J. Lipid Sci. Technol., 105 (12). 735-741.

Daun J. K. 1987. Chlorophyll in Canadian Canola and Rapeseed and its Role in Grading. 7th International Rapeseed Congress, Poland, 1451 – 1456.

Dutt, N., V., K., Prasad, D., H., L., 1989. J. Am. Oil. Chem. Soc., 66, 701.

Dziennik Ustaw Unii Europejskiej. 2010. Wspólnotowy katalog odmian roślin rolniczych (2010/C 337 A/01).

Dzieniszewski G. 2006. Analiza możliwości zasilania silnika diesla surowym olejem rzepakowym. Inżynieria Rolnicza, 12, 117-125.

Heimann S. 2005. Zasady oceny odmian i ich wartość gospodarcza. Technologia produkcji rzepaku. Wydanie specjalne dla firmy Z. P.U.H. „Best-Pest" s.j. Warszawa. 62-67.

Janowicz L. 2004. Przechowywanie nasion rzepaku w magazynach silosowych. Rzepak – VI, 47-50.

Jóźwiak D., Szlęk A. 2006. Ocena oleju rzepakowego jako paliwa kotłowego. Energetyka i Ekologia, VI, 449-451.

Kachel-Jakubowska M., Szpryngiel M., 2008. Influence of drying condition on quality of rapeseed. Int. Agrophysics.,22, 327-331.

Kachel – Jakubowska M., Zając G. 2010. Influence of fuel rapeseed oil temperature on energetic parameters of an engine. Kom. Mot. Energ. Roln. TEKA t.10, 145-152.

Krygier K., Damian K., Drąka D. 1995a. Porównanie jakości I trwałości olejów rzepakowych tłoczonych na zimno I na gorąco oraz rafinowanego. Rośliny Oleiste IHAR, XVI. 301-306.

Lichtenthaler H.K., and Buschmann C., 2001**.** Chlorophyll and Carotenoids: Measurement and Characterisation by UV-Vis Spectroscopy. In: Current Protocols in Food Analytical Chemistry, Suppl 1, Unit F4.3.1.

Muśnicki Cz. 2003. Szczegółowa uprawa roślin. Praca zbiorowa. Tom II, WAR we Wrocławiu.

Niewiadomski H. 1983. Technologia nasion rzepaku. PWN Warszawa.

Ojczyk T. 1996. Nawożenie mineralne . W: Rzepak – produkcja surowca olejarskiego. Rozdział 10, ART. Olsztyn , 163-164.

Robak B., Gogolowski M.. 2000. Zmiany fizykochemiczne zachodzące w oleju rzepakowym w trakcie ogrzewania w wysokich temperaturach z uwzględnieniem tworzenia się transizomerów kwasów tłuszczowych. Rośliny Oleiste-Oilseed Crops, XXI. 683-692.

Rojek P., Pawlik H., Praciak A. 2010. Wpływ budowy chemicznej bio-polioli z oleju rzepakowego na właściwości wiskoelastycznych pianek poliuretanowych. Czasopismo Techniczne. WPK. Zeszyt 10, 277-284.

Rosiński M., Furtak L., Łuksa A., Stępień A. 2006. Wykorzystanie olejów roślinnych i urządzeń do ich spalania w procesach suszarniczych. MOTROL. Motorization and Power Industry In Agriculture, Lublin, VOL VIIIA, 243-250.

Szlachta Z. 2002. Zasilanie silników wysokoprężnych paliwami rzepakowymi. WkiŁ, Warszawa.

Tramazi S., Lovegner N., Feuge R. 1965. Characterisation and evaluation of some rapeseed oils. J. Am. Oil Chem., 42, 78.

Tys J., Sujak A., Bogdan A. 2002. Changes to the composition of colorants caused by the temperature of drying rapeseed. Int. Agrophysics, 16, 307-312.

Wawrzosek J., Piekarski W. 2006. Udział estrów oleju rzepakoweg w mieszance paliwowej z olejem napędowym a poziom emisji tlenków azotu. MOTROL. Motorization and Power Industry In Agriculture, Lublin, Vol. VIII, 240-249.

Wcisło G. 2006. Application of the cold stamping metod for rapeseed oil extraction. Kom. Mot. Energ. Roln. TEKA t.6, 175-181.

Wcisło G. 2008. Wyznaczenie wpływu temperatury na lepkość dynamiczną biopaliw roślinnych. Inżynieria Rolnicza . 10(108), 277-282.

WPŁYW OKRESU PRZECHOWYWANIA NASION RZEAPKU OZIMEGO NA JAKOŚĆ PARAMETRÓW FIZYKO-CHEMICZNYCH DLA CELÓW PRZEMYSŁOWYCH

Streszczenie. W pracy dokonano analizy parametrów fizyko-chemicznych nasion rzepaku ozimego przechowywanych w warunkach laboratoryjnych przez okres do trzech lat. Analizie poddano parametry dotycząc poziomu wilgotności nasion, zawartości tłuszczu surowego, zawartości chlorofilu oraz określeniu lepkości oleju rzepakowego. W wyniku procesu przechowywania nasion, zaobserwowano niewielką tendencję spadkową zawartości tłuszczu surowego w próbkach oraz chlorofilu w wytłoczonym oleju. Ogólnie badane parametry jakościowe nasion oraz oleju mieściły się w granicach dopuszczalnych przez normy branżowe, czyniąc powyższe surowce cennym dla poszczególnych gałęzi przemysłu.

Słowa kluczowe: nasiona rzepaku, wilgotność nasion, tłuszcz surowy, chlorofil, lepkość oleju