"00" Oilseed Rape Cultivars in the Process of Drying

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Summary

To provide production of biodiesel fuel agriculture is required to grow "00" oilseed rape cultivars. In continuous process of the fuel production, grown oilseed rape seed should be regularly dried and properly stored. Drying rate and drying quality of the seed depends on physical conditions of the atmosphere when drying, physical and chemical properties of the material used, and the thickness of the layer through which water is diffused in the regime of drying. The study has been carried out on three "00" oilseed rape cultivars during three years period. Mathematical models of drying have been made to enable mutual comparison among the cultivars. Among the cultivars tested no significant differences were found regarding drying during one-year period. However, significant differences were found when comparison was made within the years of examination.

Key words

biodiesel, oilseed rape, drying

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Introduction

Drying is the oldest and the simplest way of conservation. Grains are dried for storing up to the balanced moisture. Balanced moisture is the value of grain moisture if there is dynamic balance of partial pressure and water steam in the air and grain. In the process, concentration of the ingredients contended has been rising up, which increases osmotic pressure. By increasing the pressure feeding and reproduction of microorganisms become more difficult (Brkić i Babić, 1978, Niketić-Aleksić, 1988).

Different batches of oilseed rape seed with different initial moisture are known to act differently in the process of drying. This process produces grain of unbalanced moisture when leaving the dryer, which could cause certain problems in storing (Krička et al., 2000, Mujumdar, 2000)

The seed are harvested when the moisture level too high for long-term preservation. Large quantities cause difficulties in storing and in preserving seed quality. In the period of storing certain chemical, biochemical, physiological, and other processes are developing in the seed. To optimally preserve seed quality until the moment of consumption and processing such activities should be slowed or even stopped by conservation (Krička, 1993, Bondoli et al., 1995).

Table 1 shows the time (in weeks) oilseed rape ought to be safely stored at the certain storage temperature and moisture content in the grain (Mc Lean, 1989).

Different content of the single seed parts and their mutual mass rates cause different behavior of the seed in the process of drying. In addition to anatomic cell structure, especially in the seed shell, anatomic parts of the seed and their relations have important role, while chemical content has lesser influence (Ward et al., 1985; Katić, 1992; Mujumdar, 2000).

For drying rate, speed of water flow through the fibre to the seed surface is very important. Such reaction of the material during the process of drying has been significantly influenced by the content of the material and properties of the different seed parts. The most significant influence to the process of discharging water from the oilseed rape seed during the process has outer pericarp. Too high temperatures destroy germ and prevent reproduction. Syariefi et al. (1987) on the basis of their investigations stated different coefficient of diffusion for single parts of the grain or seed. They found that coefficient of diffusion is 4.9 times higher for the gernm than coefficient of diffusion for farinose part of endosperm. This means that moisture migrate through the germ 3.6 – 4.9 times faster than through the endosperm under the same outdoor conditions.

According to Pliestić (1995) and Katić (1997) oilseed rape could be successfully dried in a colon of interflow dryer as well as wheat or maize, if the prior cleaning is made from all other debris.

Katić (1997) also reports that oval shape of the seed decrease porosity of the pile to minimum, which increases air resistance when drying. Oilseed rape seed in ventilation phase require up to the four times higher air pressure than wheat grain in the same phase. Table 2 shows data of oilseed rape drying in the dryers with roofs (Katić, 1997).

It is necessary to enable optimal air flow for drying and cooling. To much air in drying process and high air flow rate increases not only the air resistance, but at the certain temperature causes looseness and pile fluidisation in the roof system. In the colon, where this phenomenon exists, this could cause oilseed rape seed to stop moving, and get overheated. The result is unequally dried material that causes difficulties while long-term storing (Katić, 1994).

Material with unequal moisture content should be dried at different air temperatures. For higher moisture content, higher air temperature is needed. Temperature could be 93°C with no damage to oil quality, but seed become fragile deteriorating qualitative properties of the sample. Accepted temperature should not exceed 66°C (MAFF, 1982; Ward et al. 1985; Katić, 1994).

Krička et al (1999), investigated differences in drying rate among "00" oilseed rape cultivars that could produce biodiesel fuel (cultivars: 'Silvia', 'Karola', 'Diana', 'Semu 93 – 10', 'Semu 91 0201' and 'Lirajet'). Authors reported that in tree years period Diana cultivar needed shortest time for drying, and the longest period was needed for "00" cultivar Semu 93 – 10. The highest instability was observed in

Table 1. Estimation of the maximum storage time needed to preserve germination of oilseed rape seed depending on grain moisture and temperature in the storage (Mc Lean, 1989)

Temp. storage (°C)	Grain moisture (%)								
	6.5	7.0	7.5	8	9	10	12	14	17
	Time storage in weeks								
25	54	39	25	16	9	5	2.5	1	-
20	110	80	50	32	19	10	5	2	0.5
15	240	170	100	65	40	20	10	4	1
10	600	400	260	160	90	50	21	8.5	2
5	>1000	1000	600	400	200	120	50	17	4

Table 2. Data of oilseed rape drying in the dryers with roofs (Katić, 1997)

Methods of drying	Temperature air of drying	
	Mercantile seed	Seed
Start of drying process	50 – 55^{0}C	40 – 45^{0}C
Continuous drying	75 – 85^{0}C	50 – 60^{0}C
Approved seed temperature	40 – 45^{0}C	35 - 38^{0}C

Silvia cultivar with equal drying rate as in Diana cultivar in the first year of investigation, however, in the second and third year it was discharging moisture as long as in Semu 93 – 10 cultivar.

A few-year studies proved that drying process could be shown through mathematic models with exponents, logarithms, or polynomial equities, relatively to mutual relation of incline with derivation dw/dt (Martins and Stroshine, 1987; Katić et al., 1988; Pliestić, 1995; Krička et al., 1998; Mujumdar, 2000).

Materials and methods

The study was done during three years period on three "00" oilseed rape cultivars: 'Bristol', 'Eurol' and 'Alaska'. French cultivars 'Bristol' and 'Eurol' were produced by Monsanto S.A.S., and 'Alaska', a German cultivar by KWS.

To determine influence of the each single cultivar to the drying rate some experiments were conducted in the laboratory dryer that was placed on a digital scale. The tests were designed to simulate natural process of drying. Given air temperature for oilseed rape seed drying was 60°C, with air speed at the exit of 0.9 – 1.3 m s^{-1}. Samples were dried in thick stationary layer. For each mass change on the scale, time was recorded, and moisture loss rate was calculated while drying. Air temperature and relative humidity of the facility where the samples were examined were observed during the process.

Measurement was done in 10 replicates for each cultivar. On that basis figures and equations of the drying process were made by applying exponential and polynomial graphs. Grain moisture in particular time was determined by measuring sample mass and calculated by the following equation:

$$w_2 = 1 - \frac{m_1}{m_2} \cdot (1 - w_1)$$

where:

w_2 – grain moisture (of sample), at the moment of mass measuring, when drying,
w_1 – initial grain moisture (of sample),
m_1 – initial grain mass (of sample) and
m_2 – grain mass (of sample), at the moment of measuring

For grain moisture loss analysis during the process of drying in the dryer, a mixed model of random coefficients using procedure MIXED of SAS Ver. 8.2 was applied. As fixed factors cultivar, minute, minute2, and year were chosen as well as the interaction minute x year and minute2 x year. As random factors, intercept and minute were chosen. Apart from the statistic analysis, analysis in EXCEL was done as well.

Results and discussion

After the drying process of the cultivars tested in laboratory dryer, graphs of the water discharge from oilseed rape seed were done. Results of the drying for single cultivars tested per year were shown. Diagram 1 shows drying curves in the dryer of the Alaska cultivar in 2003, 2004 and 2005. Diagram 2 shows drying curves in the dryer of the Bristol cultivar in 2003, 2004 and 2005. Diagram 3 shows drying curves in the dryer of the Eurol cultivar in 2003, 2004 and 2005.

For grain moisture loss analysis during the process of drying in the dryer, a mixed model of random coefficients was applied as shown in Table 3.

Drying curves of Alaska cultivar showed close overlapping in seed moisture loss in the years 2003 and 2005, with 14 minutes drying needed to decrease moisture in the seed from 10% to 6%. In 2004 similar moisture loss required 26 minutes drying. Eurol cultivar for similar moisture loss in 2003 and 2005 required almost equal time, with drying period in 2003 and 2005 of 14.2 min-

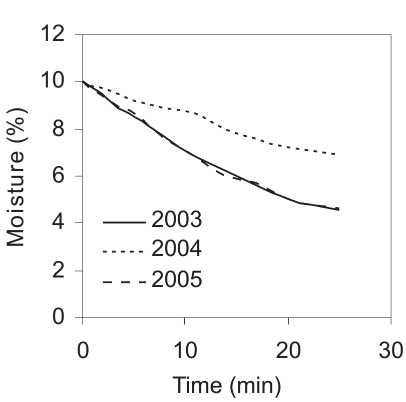

Figure 1. Drying curves in the dryer of the 'Alaska' cultivar

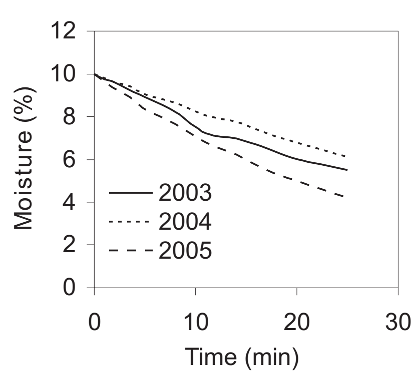

Figure 2. Drying curves in the dryer of the 'Bristol' cultivar

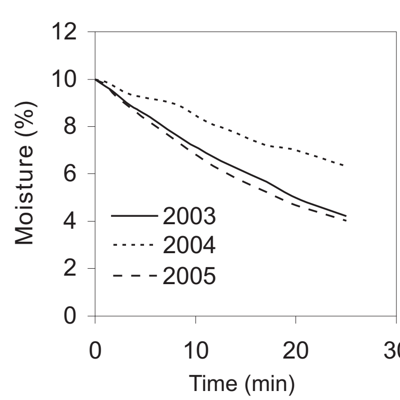

Figure 3. Drying curves in the dryer of the 'Eurol' cultivar

Table 3. Mathematical model of drying in the dryer

Cultivar	Year	Model of drying in the dryer
Alaska	2003	$w = 0.0048t^2 - 0.3435t + 10.08$
	2004	$w = 0.0012t^2 - 0.1579t + 10.01$
	2005	$w = 0.0055t^2 - 0.3574t + 10.10$
Bristol	2003	$w = 0.0037t^2 - 0.2749t + 10.08$
	2004	$w = 0.0009t^2 - 0.177t + 9.98$
	2005	$w = 0{,}0039t^2 - 0{,}326t + 9{,}97$
Eurol	2003	$w = 0.0035t^2 - 0.32t + 10.008$
	2004	$w = 0.0009t^2 - 0.1737t + 10.04$
	2005	$w = 0.0055t^2 - 0.38t + 10.073$

where: w - grain moisture in %; t – time in min

utes and 13 minutes, respectively. As Alaska cultivar, Eurol cultivar required longer drying period of 27.3 minutes in 2004. Bristol cultivar for similar moisture loss required the shortest drying rate of 14.5 minutes in 2005, and the longest drying rate of 26 minutes in 2004 for similar moisture loss. Drying rates of the cultivars tested were obtained by the first derivation of drying in the dryer. In 2003 the highest drying rate was obtained with the Alaska cultivar (coefficient of the speed incline was -0.34), followed by 'Eurol' (coefficient of the speed incline was -0.32), and 'Bristol' (coefficient of the speed incline was -0.28) with the lowest drying rate. Negative coefficient of the mathematic model applied showed decrease in the drying rate during the period of drying; at the end of the process in the dryer drying rate was the lowest. Water in the seeds of the cultivars at the end of the drying was kept by stronger forces, meaning that certain decrease in moisture required prolonged drying period.

In 2004 drying rates for the cultivars examined were lower in comparison to 2003 (coefficient of speed incline for 'Alaska', 'Bristol' and 'Eurol' were as follows: -0.16, -0.18, and -0.17). The coefficients were lower than in 2003.

In 2005 no significant differences in drying rates of the cultivars were observed (coefficient of speed incline for 'Alaska', 'Bristol' and 'Eurol' were as follows: -0.36, -0.33, and -0.38). Similar trend was reported by Krička et al. (1999)

By understanding mathematical models applied it is possible to anticipate length of the drying period; time required for dryer adjustment, by capacity, and by the power used.

Conclusions

On the basis of the three years study (2003, 2004, 2005) of oilseed rape cultivars ('Bristol', 'Eurol', 'Alaska') as resources in biodiesel fuel production further conclusions can be made:

Mathematical models of drying seed cultivars tested in a dryer determine drying curves, seed moisture, drying rate during the process, as well as the time required for dryer adjustment, by capacity and by the power used.

No significant differences were found regarding drying during one-year period among the cultivars examined. However, we found significant differences when the years of examination were compared.

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