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GRAIN QUALITY PARAMETERS OF WINTERING OAT GENOTYPES (*AVENA SATIVA* L.)

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Abstract

In the period 2010-2012 in the experimental field of the Department of Crop Production in Agricultural University-Plovdiv (Bulgaria) field experiment was conducted with 8 lines and 2 cultivars (Dunav 1 and Resor 1) wintering oats. The experiment was set in a standard method in three repetitions with the size of the plots 10.5 m^2. There was found some grain quality parameters in order to assess the potential of wintering genotypes. Line Kt 718 (14.6%) and line 07/Z1 (14.51%) have the highest amount of crude protein in the grain. The fat content is 5.04% (Kuceviste) to 8.89% (Kt 718). Starch has values which are similar for different genotypes. Line 07/Z1 has a higher value – 46.93%. The amount of ß-glucans in the grain of the tested genotypes reached 3.9%.

Key words: *wintering oats, protein, fat, starch, ß-glucans in the grain.*

INTRODUCTION

Oat grains contain 12.4 to 24.4% of protein which has the highest nutritional value among all other grain crops. Despite the genetic contingency, some authors state in their studies that they have found significant differences in the content of protein between the varieties in the different regions and year of growing (Martinez, 2010) but such influence of the agroclimatic conditions on the starch has not been established. Negative impact on grain quality and have attacks of insects (Lecheva et al., 2004).

Oat grains are relatively rich in oil compared with other cereals and can vary from 3% to 11% of grain weight in different cultivars, with lines containing up to 18% (Frey and Holland, 1999).

According to some authors, the proteins are in a state of negative dependence on the fats and according to other authors, there is no consistent relationship between these parameters (Saastamoinen, 1987).

The two main functions of ß-glucans are to improve the immune system and reduce the level of cholesterol in blood. The oats have been given a health mark owing to the ß-glucans contained their grains.

A lot of factors influence the content of ß-glucans. A number of authors have established the significance of the genotype first (Miller et al., 1993) and then the influence of the agroclimatic conditions throughout the year (Brunner, 1994).

The purpose of this survey is to establish and compare some quality indicators of the grains of eight winter lines and two winter varieties of oats.

MATERIALS AND METHODS

The field experiment was conducted within the period 2010 – 2012 in the experimental field of the Department for Plant Protection at the Agricultural University – Plovdiv (Bulgaria) on soil type Mollic Fluvisols (FAO) (Popova et al., 2012).

Eight winter lines of oats were included in the survey: No 1, 07/ Z1, 08/ Z2, M-K, Radolishta, Kuceviste, Kt 651, Kt 718 and two winter cultivars Dunav 1 and Resor 1 – yield and quality standards in Bulgaria.

The sowing was conducted in mid-October using a standard method in three repetitions

over an area of 10.5 m^2 with a sowing rate of 500 germinating seeds per sq.m. The lot had previously been planted with sunflowers. The used fertilization rate was $N_6P_8K_8$.

The laboratory analyses of the grains were performed at the Central Scientific Laboratory of the Agricultural University – Plovdiv. The analysis of raw protein was made on the grounds of BDS 13490 and the analysis of fats was made based on BDS 3412 for cereals. The quantity of starch was established using a polarographic method.

The content of ß-glucans has been determined as % of the dry substance through Mixed-linkage ß-glucan assay kit (Magazyme, Ireland), based on the enzyme method published by McCleary and Codd (McCleary B. V. and R. Codd, 1991). This method has been approved by AOAC (Method 995.16) and AACC (Method 32-23). The chaff among the oat grains was removed by hand after which the grains were ground in the laboratory mill until the size of the particles was under 0.5 mm.

The statistical processing of the experimental data was performed using SPSS V.9.0 for Microsoft Windows.

RESULTS AND DISCUSSIONS

The vegetation period 2010-2011 was favourable for the growth of oats.

The frequent and heavy precipitations in October delayed the sowing and it was performed at the end of November and the low average temperatures of 10.8°C, which is 1.8°C under the norm, delayed the growth of the plants (Table 1).

The period of tasseling, blossoming and grain formation was accompanied by heavy precipitations and the quantity of rainfall in May and June was above the norm while the temperatures were close to the typical long-term ones. The wax ripeness and the overall ripeness occur under temperatures that are 1.5°C above the norm as well rainfall that is 5.5 mm above the norm. The combination of these conditions during the period of formation and ripening of the grains has a positive influence on some of the quality indicators of the grain (Table 2).

Table 1. Average diurnal temperatures in periods of ten days (°C), 2010-2011

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	11.6	12.7	7.0	0.2	4.5	0.7	13.0	13.6	22.3	24.0
II	13.2	11.8	-1.8	4.6	2.9	9.2	10.2	17	22.5	26.7
III	7.8	9.5	2.0	-0.6	0.5	10.8	12.2	20.6	22.3	25.5
Average monthly temperature t°C	10.8	11.3	2.4	1.4	2.7	6.9	11.8	17.1	22.4	25.4
Average for the period 1965-1995	12.6	7.4	2.2	-0.4	2.2	6.0	12.2	17.2	20.9	23.2

Table 2. Amount of the rainfall during the vegetation period (mm), 2010-2011

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	27.9	-	4.4	2.7	-	9.9	2.0	31.3	8.6	6.6
II	48.7	11.0	14.4	4.4	28.1	57.8	16.8	8.4	28.6	7.3
III	42.5	4.4	10.2	17.5	24.0	6.7	-	1.1	4.3	0.7
Monthly amounts	119.1	15.4	28.7	24.6	52.1	74.4	18.8	40.8	41.5	14.6
Average for the period 1965-1995	47	35	36	40	48	44	39	32	36	42

Table 3. Average diurnal temperatures in periods of ten days (°C), 2011-2012

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	15.3	7.3	3.4	-0.2	-4.5	4.1	11.2	19.6	21.3	25.9
II	10.6	1.8	5.1	1.5	-3.1	8.1	14.3	16.5	24.6	27.5
III	8.7	2.4	-1.6	-3.0	3.5	13.2	17.7	16.6	24.9	27.5
Average monthly temperature t°C	11.6	3.8	2.3	-0.6	-1.4	8.4	14.4	17.6	23.6	27.0
Average for the period 1965-1995	12.6	7.4	2.2	-0.4	2.2	6.0	12.2	17.2	20.9	23.2

Table 4. Amount of the rainfall during the vegetation period (mm), 2011-2012

Months periods of ten days	X	XI	XII	I	II	III	IV	V	VI	VII
I	22.8	0.0	0.4	65.6	47.2	2.0	13.5	37.3	40.1	0.0
II	38.3	0.8	12.6	0.0	2.6	2.7	8.2	73.7	0.0	2.0
III	9.3	0.1	25.8	54.6	7.0	0.2	0.5	49.8	2.3	0.4
Monthly amounts	70.4	0.9	38.8	120.2	56.8	4.9	22.2	160.8	42.4	2.4
Average for the period 1965-1995	47	35	36	40	48	44	39	32	36	42

The period of vegetation 2011-2012 was characterized as not very favourable for the growth of the winter oats.

The large amount of rainfall in October 2012 (70.4 l/m^2) delayed the sowing of the winter genotypes of oats (Table 4).

The period of grain formation and ripening (May-June) was characterized by temperatures close to and a little above the norm for the multi-year period and also by heavy precipitations in May and quantity of the rainfall above the norm in June (Table 3). This combination of weather conditions was favourable for the formation and the nutrition of the already existing grains on the ear, which is a prerequisite for the relatively high weight of the grains in the panicle.

Based on the conducted chemical analyses of the grains of the examined genotypes during the period of the survey, the highest amount of raw protein was established in line Kt 718 (14.60) and line 07/Z1 (14.51) (Table 5). All genotypes have a high content of proteins above the standard Resor 1 cultivar, with the exception of line Kuceviste.

The quantity of fats varies for the different genotypes. With reference to the selection and the use of oat grains as healthy food, we aim at achieving a lower quantity of fats in the grains.

The high content of fats impedes the long-term storage of the production. The lowest quantity of fats was established in line Kuceviste – 5.04% and Kt 651 (5.83%). All lines are characterized by a low content of fats in the grains compared with the cultivar Dunav 1 and the standard variety Resor 1 (7.13%), with the exception of line Kt 718 which was proven to have the highest content of fats (8.89%) of all genotypes included in the survey.

The content of starch varies as the values are relatively close between the different genotypes and the highest value was registered for the grains of line 07/Z1 (46.93%). Lines M-K and Kt 651 (45.88 and 45.62%) are also above the standard cultivar Resor 1.

Table 5. Average content of raw protein, fats and starch in the winter genotypes of oats for the period,%.

Genotypes	Absolute dry substance (%)	Raw protein	Fat	Starch
Line No 1	90.95	13.03 e	6.79 c	42.90 f
Line 07/Z1	90.00	14.51 a	6.37 e	46.93 a
Dunav 1	90.76	13.30 d	7.11 b	43.00 e
Linie 08 / Z2	90.61	13.90 b	6.62 d	44.08 d
Line M-K	91.07	13.45 cd	6.17 f	45.88 b
Kt 651	90.57	13.66 c	5.83 g	45.62 b
Resor 1 /st	90.93	11.86 f	7.13 b	44.94 c
Kt 718	90.64	14.60 a	8.89 a	44.57 c
Radolista	91.09	13.33 d	6.38 e	44.86 c
Kuceviste	90.95	11.42 g	5.04 h	43.91 d

The content of fibre including ß-glucans in oat grains has been very important over the last decades as regards the use of the grains in healthy food. The ambition to discover a cultivars or create one that contains a maximally high content of ß-glucans (the highest content in the world so far is up to 6-7%) is one of the main goals of many researchers.

There are a lot of factors that influence the content of ß-glucans and one of them is the weather conditions, due to which the numbers vary during the years of the survey (Georgieva et al, 2010).

Within the period of the survey, the year when the largest quantity of ß-glucans was accumulated was 2011 followed by 2010 and 2012.

Out of all examined genotypes, the one with the largest quantity of ß-glucans is line 08/Z2 – 3.948% followed by line Kt 718 (3.746%). All examined lines surpass Resor 1 cultivar in terms of ß-glucans content and six of them also surpass Dunav 1 cultivar (Table 6).

As an indicator showing the percentage of chaff and the percentage of hulled grain, the presence of chaff is very important for the food industry. The examined genotypes have a different proportion of hulled grain and chaff during the years of the survey (Table 7).

Table 6. Quantity of ß-glucans in the grains of the examined genotypes of oats

Genotypes	Absolute dry substance (%)	2010	2011	2012	Average for the period, ß-glucan (%)
No 1	90.83	1.582 e	3.430 f	2.623 i	2.545 c
07/ Z1	90.05	3.377 b	2.676 h	2.366 j	2.806 bc
Dunav 1	90.12	3.164 c	3.249 g	2.828 h	3.080 b
08/Z2	89.46	3.722 a	4.065 c	4.057 a	3.948 a
M-K	90.60	3.008 d	3.426 f	2.870 g	3.101 b
Kt 651	90.78	-	3.739 e	3.150 c	3.444
Resor 1	90.33	-	1.645 i	3.142 d	2.393
Kt 718	90.36	-	4.090 b	3.402 b	3.746
Radolishta	90.31	-	3.797 d	3.025 e	3.411
Kuceviste	90.51	-	4.097 a	2.946 f	3.521

Table 7. Percentage of hulled grain and chaff in years and on average for the period for all examined winter genotypes of oats.

Genotypes	2010 r.		2011 r.		2012 r.		Average for the period, %	
	Hulled grain (%)	Chaff (%)	Hulled grain (%)	Chaff (%)	Hulled grain (%)	Chaff (%)	Hulled grain	Chaff
No 1	80.05	19.95	86.50	13.50	73.70	26.30	80.08	19.9
07/ Z1	78.50	21.50	76.20	23.80	70.35	29.65	75.02	24.9
Dunav 1	-	-	74.50	25.50	73.30	26.70	73.90	26.1
08/Z2	66.50	33.50	64.90	35.10	71.85	28.15	67.75	32.2
M-K	70.50	29.50	85.20	14.80	73.60	26.40	76.43	23.6
Kt 651	-	-	70.95	29.05	70.30	29.70	70.62	29.4
Resor 1	-	-	71.65	28.35	70.05	29.95	70.85	29.1
Kt 718	-	-	74.90	25.10	74.45	25.55	74.67	25.3
Radolishta	-	-	73.75	26.25	70.55	29.45	72.15	27.8
Kuceviste	-	-	70.50	29.50	69.25	30.75	69.87	30.1

During the vegetation period 2010-2011, the genotypes have a higher percentage of hulled grain compared with the vegetation period 2011-2012. On average for the period of observation, the highest percentage of hulled grain was registered for line No 1 – 80.08% followed by line M-K (76.43%) and line 07/Z1-75.02%.

The highest percentage of chaff was registered for line Kuceviste – 30.1%, which, therefore, has the lowest percentage of grains.

CONCLUSIONS

Some new lines of winter oats with a high quantity of proteins are line Kt 718 – 14.6% and line 07/ Z1. The content of fats varies from 5.04 to 8.89% and the content of starch varies from 42.9 to 46.93. Depending on their use, we can choose genotypes with different proportions of the main nutrients.

The highest content of ß-glucans was registered for line 08/Z2-3.95% followed by lines Kt 718 (3.75%) and Kuceviste (3.52%).

A relatively large percentage of hulled grain and low percentage of chaff was registered for line No 1 (80.09%/19.9%), line M-K (76.43%/23.6%) and 07/Z1 (75.02%/24.9%).

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