QUALITY OF TRITICALE FROM ECOLOGICAL AND INTENSIVE FARMING*

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Triticale as a new cereal species has several ecologically good qualities suitable for its utilisation in ecological farming. We studied the possibility of food usage – milling and baking quality from ecological farming. Analyses were done by standards and EU standards and ICI. The content and fraction composition of proteins according to the traditional method after Osborne and evaluation using SDS-PAGE electrophoretic analysis. Triticale grain from ecological as well as from intensive cultivation is not suitable for traditional baking utilisation – for preparation of proofing doughs. The highest content and representation of albumins and globulins was found in triticale in ecological and intensive farming. In ecological cultivation the content of prolamines and glutelins was decreasing, but representation of albumins and globulins was significantly highest. The content of crude protein and all fractions was increasing with higher intensity of cultivation and their representation, the most in prolamines. The total content of crude proteins was significantly lowest in ecological cultivation. High-molecular weight groups (HMW) were lower in ecological cultivation than in intensive cultivation. In low-molecular weight (LMW + gliadin) the difference between cultivations was not recorded. The residue of albumins and globulins was insignificantly higher in ecological cultivation. Ecological farming does not improve baking quality of triticale, but affects the structure of proteins in favour of nutritionally more valuable albumins and globulins. It can condition better feed value of triticale that was proved earlier. The grain yield in ecological cultivation was 88% of the yield of intensive farming.

triticale; organic farming; ecological cultivation; baking quality; structure of proteins

INTRODUCTION

Triticale manifested a high yield potential at the beginning of the 1980s and it was spreading very fast in agricultural practice. Greater concern for its cultivation was caused by a lot of economic qualities, is tolerance to worse cultivation conditions, forecrop and need of lower agrochemical inputs, fertilizers and pesticides. With its introduction into a wide cultivation practice was also a hope that triticale will be classified among bread-making cereal and will replace less yielding rye. Relatively extensive research of milling and baking properties showed that present triticale varieties are not suitable for baking processing for bread and bakery products and at present they cannot replace rye so far. As regards the progress in breeding of triticale such varieties could be obtained certainly in the future.

Present varieties are valued for their high feed value that is probably connected with the structure of proteins. The aim of our study to assess the quality in ecological farming where this species is very promising, just for the possibility to get biofeeds for ecological rearings of animals, followed by its possibility even in less favourable conditions, capacity of nutrient intake and good health conditions of the triticale varieties.

Literary data on the quality of triticale are relatively extensive, because from the very beginning of its cultivation research institutes were interested in the chemical structure of grain as well as milling and baking quality. The combination of good baking quality after wheat and sensory priorities of rye bread was expected. However, this was not manifested. The problems during clearing were manifested as early as in input for milling processing. The grain of original varieties was shrunk with rather frequent occurrence of sprouted grains and also with admixture of sclerocia of ergot. The majority of evaluation of quality of triticale coincides in it that parts of the grain have strongly variable physical properties together with fluctuating content of substances, and hence also a technological quality. It is a strong share of effect of agroecological conditions of cultivation and variety. Many research institutes evaluate the properties of triticale in such a way, e.g. the Federal Centre for Cereal, Potato and Lipid Research Detmold, Germany (Weipert et al., 1986), the Research Institute of Milling and Baking Industry in Prague, Czech Republic (Plocek, 1980; Petr, Kaisrová, 1990).

Till the end of the 1980s Polish triticale varieties were the most spread. The whole this collection of excellent varieties (11 varieties from locality, where they were bread) was evaluated by Haber (1989). From his results followed average thousand-kernel weight (TKW), test weight 72.9 kg/hl, flour yield 68.1%, and ash content 0.62%. The protein content was 11.1% (3.2–34.4%),

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amylographic maximum 238 AU and Falling number 173 sec. Bona et al. (2002) found in 18 Hungarian varieties the protein content amounting to 11.2% and SDS test 10.3 ml. From our observations of milling and baking quality compared to wheat and rye Petr et al. (1991) confirmed generally predominating opinions that present triticale varieties are suitable for baking processing of proofing dough and traditional preparation of bread and bakery products. However, there are studies that show the possibility to use triticale for preparation of special dietary products that are recommended for limitation of civilisation diseases. Technologies for production of flakes, cereal breakfast and bread making products are known. It may be associated with the composition of the triticale proteins where higher content of soluble proteins, albumins and globulins is.

These protein fractions have the highest nutritive value and essential amino acids are bound to them. On the contrary, reserve proteins, prolamins and glutenins have the lowest nutritive value but they significantly affect baking quality. Čerešňáková (1991) reports albumins in wheat 17.7% and in triticale 17.1% of globulins in wheat 9.9% and in triticale 12.7%. Prolamins in wheat 49.7 and triticale 40.8, glutenin 20.1 and 18.4 in triticale. Rest form 7.6 and 10.9%. Such structure of protein fractions leads us to verification of the possibility to use triticale for the diet at celiac disease. We found sub-limit values of proteins in ELISA test in the variety Presto in 2000. In the following year in a wide spectrum of varieties (Disko, Marko, Modus, Kolor, Presto, Tricolor and Sekundo) it was in all varieties and the limit value of 10 mg/100 g of dry matter was exceeded in ecological and intensive cultivation. Fluctuation of protein contents manifested the triticale as an unsuitable crop for the diet for celiac patients (Petr et al., 2003).

Generally, high feed value of grain is its most significant benefit. It was confirmed as soon as in the first feeding experiments. It is explained by higher content of proteins and their structure. As we mentioned above, great variability of the protein content was manifested according to the cultivation system, particularly by nitrogen fertilization and dependence on weather as well. Present varieties have not such a great content of proteins compared to that of the 1980s (Boros, 2002), and therefore it is supposed that representation of different fractions is of greater importance. This is the difference between triticale and other cereals. Experiments of Němec et al. (1988) showed as early as in the mid-80s a high protein production index PER (Protein Efficiency Ratio). In triticale varieties it was 63.2% (casein 100%), in a collection of wheat varieties 38.8%. In our experiments, too (Petr et al., 2004), with rats the triticale variety Kolor had the best feed conversion statistically significantly (3.85 compared to wheat varieties 4.94, and increment 4.38 g/day, compared to wheat 2.97 g/day). It was proved by a lot of studies and results of feeding tests from all countries where cultivation of triticale was spread.

Antinutritive substances (alkylresorcinols) and trypsin inhibitors occur in parental forms of triticale. Boros (1988) studied the content of these substances in several triticale varieties compared to wheat Grana and the most spread population variety of winter rye. Lower content of alkylresorcinols in triticale was found, and the content of trypsin inhibitor wheat contained 0.35, rye 1.45 and triticale 0.75. Knoblauch (1985) carried out in the USA an extensive screening of triticale, rye and wheat varieties, and he confirmed that the lowest content of these substances was in wheat and the highest in rye. In triticale a part of varieties by the content of inhibitors was close to wheat and a part was close to rye. The values of the content were strongly dependent on the site and conditions of cultivation (weather pattern).

We did not find concrete data on the quality of triticale in ecological farming. It can be judged according to the quality of wheat and rye from this cultivation, what is presented in publications by Petr, Škeřík (1999) and Petr, Mikšík (2006). We are concentrated in this study on the milling and baking quality of triticale from ecological farming with respect to quality of proteins.

MATERIALS AND METHODS

In the years 2001–2003 analyses of grain samples were done from seven triticale varieties that were cultivated in different localities and different intensity. Varieties were cultivated intensively at testing stations of the Central Institute for Supervising and Testing Hradec near Svitavy, Lípa near Havlíčkův Brod and in the last year also at the station Krásné Údolí in western Bohemia. Samples from ecological cultivation were obtained from the Experimental Station of the Czech University of Agriculture at Uhříněves near Prague.

The Testing Station in Hradec is located in potato-growing region at an altitude 450 m above sea level with average annual temperature of 6.5 °C and annual sum of precipitation is 625 mm. Production potential of soil is 67 points. The Testing Station Lípa is placed in cereal-growing region at the altitude 505 m with annual average temperature 7.7 °C and sum of precipitation is 632 mm. The Testing Station Krásné Údolí is situated in forage-growing region at an altitude 647 m, with the annual average temperature 6.3 °C and sum of precipitation 602 mm. Research Station Uhříněves is placed at the altitude 295 m above sea level with the long time average annual temperature 8.4 °C and the sum of precipitation 575 mm. Production potential of soil is height – 84 points.

The grain of the varieties Presto and Disco, Danko (Poland) Sekundo and Marko, Hod. Roslin Szelejewo Poland; Kolor, Selgen Czech Republic; Tricolor, Florimond, Desprez (France), and Modus, Nordsaat (Germany) were analysed. The seed was treated in intensive farming and the stands were treated only by herbicides and fertilized by 60–90 kg of nitrogen and basic

doses of P and K. 110 kg of N was used in winter triticale in higher intensity for fertilization, fungicide, insecticide and growth regulator were applied. Ecological experiments were carried out on certified and controlled experimental area without fertilization and pesticides according to IFOAM principles (International Federation of Organic Agriculture Movement) and regulations of Ministry of Agriculture of Czech Republic for ecological agriculture.

We evaluated milling and baking quality of triticale by Czech standards (ČSN) and ICC methods (International Association for Cereal Chemistry) for wheat and rye (ČSN 461011, flour analyses ČSN 560512, Falling number ČSN ISO 3093, amylographic analysis by ICC 148.

In 2004 we also studied the structure of proteins using electrophoretic analysis.

The crude protein (determined by usage method according to Kjeldahl). Protein nitrogen (determined by usage method after Berstein). The structure of protein fractions by discontinuing fractionation according to Osborne, modification after Michalík et al. (1994) and Michalík (2002). The whole grain grout was used for the determination alone. Albumins + globulins were determined by extraction 10% of NaCl (45 min at 20 °C, stirring replicate 3 times), prolamines by extraction 70% ethanol (45 min at 20 °C, stirring replicate 3 times), glutelins by extraction 0.2% of NaOH (45 min at 20 °C, stirring – replicate 3 times).

We studied the structure of reserve proteins by electrophoretic analysis (SDS-PAGE ISTA after Wrigley (1992). Standard vertical discontinuing electrophoresis in polyacryl amid gel in the presence of sodium dodecyl sulphate (SDS), device SE 600 electrophoresis unit, Hoefer Pharmacia Biotech. Electrophoretic structure of prolamin proteins (A-PAGE).

The results of quality analyses were statistically evaluated by the method of analysis of variance of multiple classification ANOVA using Tukey test and programme SAS 6.12/1996 with expression of parameter of the Fischer test F and minimum significant difference on the level of significance $\alpha = 0.05$. The correlation was evaluated by correlation analysis using the programme Microsoft Excel 5.0/95 with expression of statistical significance of correlation coefficients on the level of significance $\alpha' = 0.05$. The share of different factors in quality indicators was calculated in percentage from *F*-values for the years, varieties, intensities of cultivation and locations.

RESULTS AND DISCUSSION

There are several serious reasons for use of triticale in ecological farming.

We tested the changes of milling and baking quality of triticale in ecological cultivation compared to intensive cultivation. It is evident from Tables 1 and 2 that there were only smaller differences. TKW in ecological farming was in both experimental years higher, which is connected with thin stands in this system, and was significantly different by sites. In 2001 in ecological cultivation protein content was much lower. However, in second experimental year the content of proteins was very variable by varieties (9.8–11.8%) but almost identical in both cultivation systems on average for varieties. Falling number, too, which characterises enzymatic activity, is an important purchase criterion, was not much different in 2001 in intensive and ecological farming classified by sites and varieties. On the contrary in 2002 average value of falling number in intensive growing reached 223 sec. and was by 141 sec. higher compared to ecological growing. During all years cultivar Sekundo was distinguished with high falling number. It was manifested also on the level of amylograph. Viscoelastic properties expressed by sedimentation test (SDS test in grout) that expresses in wheat in total amount and quality of proteins and has a minimum value 45 mL, was ranging in triticale intensively cultivated from 26 to 29 mL, in ecological cultivation 19–28 mL. We found here a significant correlation between content of protein and SDS test ($r = -0.81$). Maltose content shows damage to starch grains during grinding and activity of amylolytic enzymes. The contents found are good, only in 2001 in the locality they are high (3.1%). There is probably a latent sprouting.

We have no quality indicators from 2003 from ecological farming because the stands froze in unfavourable winter. We evaluated the quality of different varieties from intensive cultivation out of three localities (Table 3). The highest TKW was in variety Disco and Krásné Údolí, and the effect of locality was decisive. Bulk weight (TW) was relatively balanced, ranging between 70.5 and 75.8 kg/hl. The protein content was also balanced, on average 10.2% (9.3–10.9%), significantly higher from locality Hradec. Relatively high values of Falling number were manifested that exceeded stated minimum values for food rye (80 sec., for trade quality and 120 sec. for basic quality). Differences according to varieties and localities could be observed, significantly in locality Lípa. The variety Sekundo reached the highest significant values of Falling number out of all experimental sites. The situation was similar in maximum values of amylograph. In loaf volume, as a main criterion, differences in quality of varieties and effect of localities were not proved. The flour yielding reached on average 68.5% in all and sedimentation test according to Zeleny was approximately 16 mL. These results are in correlation with the values found in a set of triticale varieties by Kučerová et al. (1998) and other authors: Haber et al. (1989), Boros (2002), Weipert et al. (1986) and others. Despite it, it can be presupposed that in this quality characteristics it will be possible to prepare from triticale some kinds of baking and dietary products, protein concentrates, pasta etc. as it was referred by Popovič, Rafajlovič (1984), and Petrov, Želev from the Research Institute of Cereals in Tolbuchin, Bulgaria (personal communication).

Table 1. Quality of triticale from intensive and ecological cultivation in 2001

Locality	Varieties	1000 kernel weight g	Test weigh kg/hl	Protein %	Falling number s	Sedimentation test grout ml	Maltose %	Ash %	Amylograph max. AU
Hradec INT A	Presto	48.8	77.7	10.78	85	39	2.0	1.73	90
	Kolor	43.3	67.0	10.50	62	29	3.9	1.84	30
	Disco	50.4	77.5	10.91	64	26	3.8	1.5	60
	Modus	44.5	68.5	9.32	62	20	4.5	1.87	30
	Sekundo	43.8	66.5	11.31	129	32	1.2	2.05	150
	Average	**46.1**	**71.4**	**10.56**	**80**	**29**	**3.1**	**1.80**	**72**
Lípa INT B	Presto	36.8	62.5	9.45	76	32	1.7	1.92	90
	Kolor	38.7	71.0	9.22	65	25	2.0	1.98	60
	Disco	34.1	59.7	9.95	84	24	1.7	2.14	80
	Modus	39.9	61.5	9.06	63	23	2.5	1.99	65
	Sekundo	37.2	63.0	8.78	204	26	1.9	1.98	210
	Average	**37.3**	**63.5**	**9.09**	**98**	**26**	1.9	**2.00**	**101**
Uhříněves ECO	Presto	50.7	72.0	8.85	62	23	2.0	1.74	45
	Kolor	54.6	69.3	8.40	62	21	1.6	1.83	55
	Disco	52.7	69.0	8.60	76	20	1.4	1.94	80
	Modus	55.7	6.81	7.56	63	15	1.7	1.72	75
	Sekundo	51.8	73.0	8.20	152	18	3.5	1.81	194
	Average	**53.1**	**70.3**	**8.32**	**83**	**19**	**2.0**	**1.81**	**90**
Difference	**ECO-INT A**	**+7**	**–1.1**	**–2.24**	**+3**	**–10**	**–1.1**	**+0.01**	**+18**
	ECO-INT B	**+15.8**	**+6.8**	**–0.77**	**–15**	**–7**	**+0.1**	**–0.19**	**–11**

Table 2. Quality of triticale from intensive and ecological cultivation in 2002

Locality	Varieties	1000 kernel weight g	Test weight kg/hl	Protein %	Sedimentation test in grout ml	Falling number s	Maltose %	Ash %
Hradec INT	Presto	38.1	72.2	10.66	34	248	1.7	1.83
	Kolor	39.7	67.9	11.12	30	163	1.3	1.97
	Disco	38.6	67.5	10.96	29	121	1.2	1.95
	Modus	38.5	67.6	10.91	21	223	1.5	1.92
	Sekundo	39.1	68.6	10.57	29	326	1.0	1.94
	Marko	33.5	68.3	9.92	32	224	1.0	1.88
	Tricolor	37.9	70.3	10.48	28	267	0.9	1.89
	Kitaro	37.3	72.5	10.38	33	204	1.6	2.00
	Lamberto	33.1	68.5	11.04	27	235	0.9	2.05
	Lupus	34.7	71.9	10.56	28	240	1.2	1.92
	Ticino	33.0	66.2	10.69	31	203	1.6	1.93
	Average	**36.7**	**69.2**	**10.66**	**29**	**223**	**1.2**	**1.93**
Uhříněves ECO	Presto	43.6	69.3	10.76	33	70	2.0	2.00
	Kolor	47.3	67.7	11.37	31	62	2.0	1.99
	Disco	49.3	67.3	11.28	31	62	2.8	2.05
	Modus	48.7	67.1	10.40	21	68	2.1	1.95
	Sekundo	48.8	69.7	9.95	31	156	1.9	2.01
	Marko	42.7	68.1	9.85	25	77	1.8	1.92
	Average	**46.7**	**68.2**	**10.60**	**28**	**82**	**2.1**	**1.98**
	Difference	+10.0	–1.0	–0.06	–1	–141	+0.9	+0.05

Table 3. Technological quality of triticale from different localities

Varieties	Locality	1000 kernel weight g	Test weight kg/hl	Protein %	Falling number s	Maltose %	Ash %	Amylograph max. AU	Bread volume cm^3
Presto	Hradec	44.1	76.1	11.1	71	1.91	0.50	80	1080
	Lípa	38.3	74.0	10.5	115	1.92	0.50	130	1020
	Krásné Údolí	41.5	77.5	10.9	85	1.47	0.48	100	960
	Average	**41.3**	**75.8**	**10.8**	**90**	**1.76**	**0.49**	**100**	**1020**
Kolor	Hradec	47.2	70.3	10.9	65	1.67	0.50	70	1060
	Lípa	41.2	68.3	9.5	127	1.48	0.52	130	1020
	Krásné Údolí	47.8	73.1	10.2	99	1.17	0.47	120	940
	Average	**45.4**	**70.5**	**10.2**	**97**	**1.44**	**0.49**	**110**	**1010**
Disco	Hradec	50.7	72.5	11.1	71	2.28	0.50	40	1000
	Lípa	43.8	72.2	9.7	100	1.49	0.49	120	960
	Krásné Údolí	46.4	74.4	10.0	66	1.43	0.44	60	1000
	Average	**46.9**	**73.0**	**10.4**	**79**	**1.73**	**0.48**	**70**	**980**
Modus	Hradec	39.5	78.8	9.6	131	1.47	0.50	210	980
	Lípa	36.5	71.9	9.4	161	1.55	0.51	230	940
	Krásné Údolí	45.1	73.1	9.0	127	1.5	0.49	210	950
	Average	**40.3**	**74.6**	**9.3**	**139**	**1.35**	**0.49**	**216**	**950**
Sekundo	Hradec	44.0	72.6	11.0	252	1.48	0.49	250	920
	Lípa	39.8	71.4	9.7	322	1.18	0.42	370	980
	Krásné Údolí	49.4	74.6	9.6	278	0.93	0.42	370	980
	Average	**44.4**	**72.8**	**10.1**	**284**	**1.19**	**0.45**	**330**	**970**
Tricolor	Hradec	32.3	74.1	12.7	62	2.5	0.53	30	900
	Lípa	36.5	71.2	9.7	76	1.30	0.48	70	960
	Krásné Údolí	45.1	74.1	10.4	66	1.41	0.51	50	980
	Average	**37.9**	**72.4**	**10.9**	**68**	**1.58**	**0.50**	**50**	**950**
Averages	Hradec	42.7	74.0	11.0	108	1.81	0.50	113	990
	Lípa	39.3	71.5	9.7	150	1.48	0.48	175	980
	Krásné Údolí	45.8	74.4	10.0	120	1.24	0.47	151	970
	Average	**42.6**	**73.2**	**10.2**	**126**	**1.51**	**0.48**	**146**	**980**

Excellent feeding value of triticale belongs to its most valued qualities that should bring a possibility of extension of feed resources in ecological farming to ecological rearings of livestock and to production of ecological animal bioproducts that are required the most in the market. Generally, the principle of this feeding value consists of the structure of protein fractions of triticale. In cooperation with the Slovak University of Agriculture in Nitra we studied the content of crude protein and protein fractions. Mean values from a set of varieties are presented in Table 4.

Our previous results with wheat and rye are confirmed from the list of mean values of the content of crude proteins (Petr, Škeřík, 1999; Petr, Mikšík, 2006) that increased intensity, particularly with higher nitrogen fertilization, increases the content of all crude proteins.

The fraction structure of proteins in triticale showed the highest content of albumins and globulins in ecological and intensive cultivation and their highest representation. Much lower content of prolamins and glutelins was recorded in ecological cultivation.

Intensive cultivation was increasing the content of all fractions, the most of prolamins. Mean values are in Table 5.

Table 4. Mean values of crude protein of triticale from ecological and intensive cultivation

Varieties	% of total N	Crude protein % (N x 5.7)	% of protein N
Triticale ECO	1.10	6.29	0.88
Triticale INT	1.25^{+}	7.14^{+}	1.00^{+}

$^{+}$ significant difference

Table 5. The structure and representation of protein fractions of triticale in ecological and intensive cultivation

Varieties	Albumins + globulins % N	Prolamins % N	Glutelins % N	Rest % N
Triticale ECO	0.454 NS	0.296^{+}	0.218^{+}	0.125
Percentage	41.20 NS	26.85^{+}	19.76 NS	11.39
Triticale INT	0.487 NS	0.370^{+}	0.261^{+}	0.128
Percentage	38.99 NS	29.41^{+}	20.72 NS	10.29

NS – non significant difference, $^{+}$ – significant difference between ECO and INT

Table 6. Representation of protein fractions of winter wheat varieties from ecological and intensive farming (Krejčířová, 2005).

Varieties – quality baking group	Albumins + globulins %	Prolamins %	Glutelins %	Rest N %
Uhříněves ECO				
Elite varieties E	21.66	37.31	29.69	11.35
Quality varieties A	22.01	37.44	28.10	12.44
Bread varieties B	23.38	36.27	28.93	11.43
The other varieties C	25.50	37.41	26.64	11.45
Stupice INT				
Elite varieties E	18.27	40.06	34.10	7.58
Quality varieties A	18.12	38.97	31.93	10.97
Bread varieties B	19.49	37.14	30.70	12.66
The other varieties C	24.97	32.03	28.37	14.64

The structure of protein fractions in rye of hybrid varieties confirmed the similar regularities. The content of all fractions was rising with higher intensity, but more the content of prolamins and glutelins was increasing more. Representation of soluble fractions was higher in ecological farming. The situation was opposite in rye population varieties when the content of proteins was higher in ecological farming and lower in intensive farming. It has happened also in our previous study (Petr, Mikšík, 2006) and we shall devote to the explanation further. The content of albumins and globulins in wheat amounted to 0.382 and 0.412% and representation only 25%, content of prolamins was 0.561 and 0.598% and representation about 37%. The content of glutelin in wheat was 0.466 and 0.407% and representation was 27–28%.

Representation of protein fractions in wheat from ecological farming from the same experimental year was studied by Krejčířová (2005) who also found higher

Table 7. Quantitative evaluation SDS-PAGE of electrophoretic analysis of reserve (gluten) – proteins of triticale, rye and wheat

Number of sample	Species – variety	TKW %	LMW + gliadins %	Residual alb. + glob. %
Standard	Chinese spring wheat	16.29	34.25	49.48
Standard	Marquis spring wheat	18	57.24	24.75
1	Triticale Disco ECO	5.36	71.08	23.57
2	Triticale Disco INT	7.47	62.45	30.7
3	Triticale Sekundo ECO	6.93	67.22	25.83
4	Triticale Sekundo INT	6.73	71.51	21.76
5	Triticale Presto ECO	7.9	71.96	20.15
6	Triticale Presto INT	6.83	58.35	34.79
7	Triticale Kolor ECO	7.31	66.13	26.59
8	Triticale Kolor INT	5.6	75.97	18.43
9	Triticale Modus ECO	4.57	65.02	30.43
10	Triticale Modus INT	8.42	58.28	33.31
11	Triticale Marko ECO	4.1	55.1	40.88
12	Triticale Marko INT	10.75	64.71	24.54
Average	**Triticale ECO**	**6.1**	**66.08**	**29.90**
Average	**Triticale INT**	**7.63**	**65.21**	**27.15**
13	Hybrid rye Apart ECO	6.21	66.19	27.61
15	Hybrid rye Apart INT	11.9	21.7	67.85
16	Hybrid rye Picasso ECO	4.99	61.68	33.33
18	Hybrid rye Picasso INT	5.4	61.92	33.05
Average	**Hybrid rye varieties ECO**	**5.60**	**63.93**	**30.47**
Average	**Hybrid rye varieties INT**	**8.6**	**41.49**	**50.45**
19	Rye Selgo ECO	5.9	77.69	16.41
21	Rye Selgo INT	3.82	70.09	26.11
22	Rye Daňkovské Nowe ECO	8.71	69.13	22.16
24	Rye Dankow.Nowe INT	7.42	56.89	35.7
Average	**Rye population varieties ECO**	**7.30**	**73.41**	**19.28**
Average	**Rye population varieties INT**	**5.62**	**63.43**	**30.90**
25	Wheat Alibaba INT	23.24	66.62	10.14
26	Wheat Bill INT	24.75	66.65	8.57

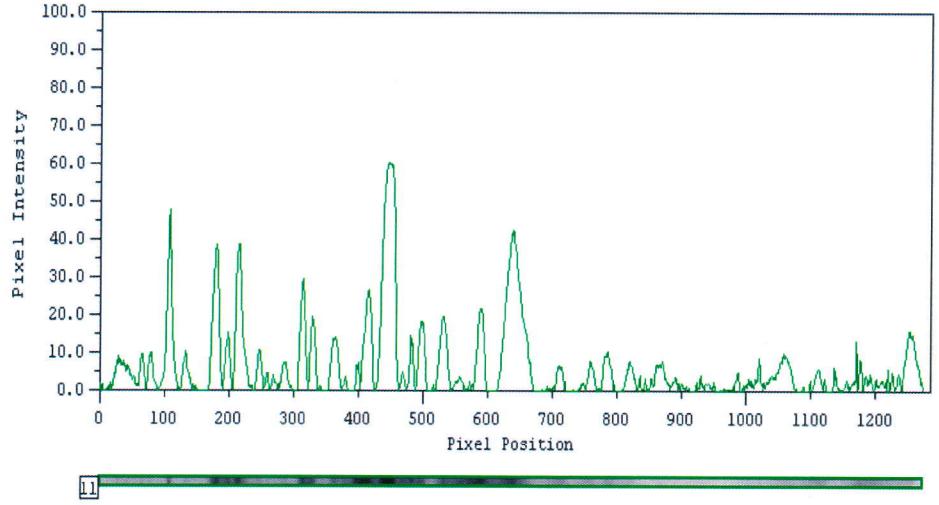

Fig. 1a. Elektrophoretic spectrum of proteins in the varaiety Presto ECO

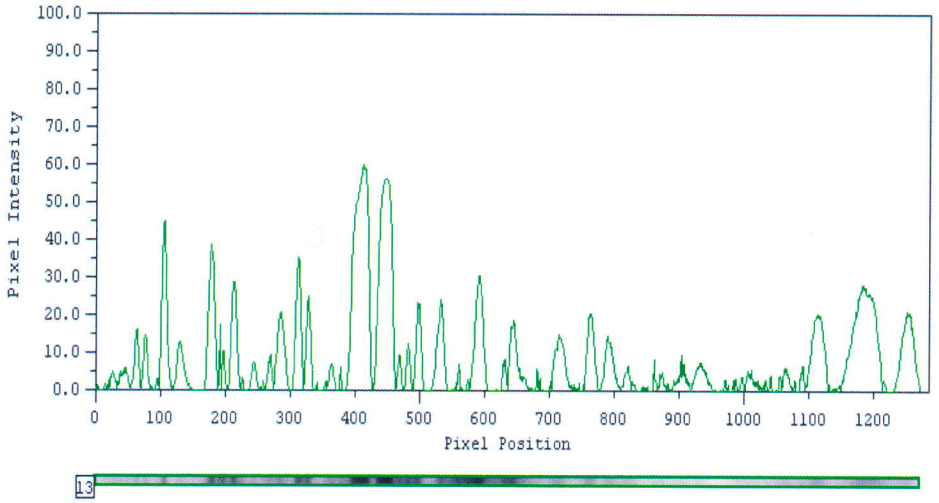

Fig. 1b. Elektrophoretic spetrum of proteins in the varaiety Presto INT

representation of albumins and globulins from ecological farming for the benefit of prolamins and glutenins compared to intensive cultivation (Table 6).

Differences in varieties appeared here when wheat varieties from group C had the greatest representation of albumins and globulins in ecological and intensive cultivation, and on the contrary, varieties of group E, with high baking quality, had greatest representation of prolamins and glutelins in intensive farming.

Quantitative evaluation of SDS-PAGE of electrophoretic analysis of reserve (gluten) proteins of triticale is in Table 7. The research was devoted to quantitative evaluation of high-molecular HMW and low-molecular LMW relatively in details, because these components decide upon baking quality. Our results also confirm in wheat (both standards of spring wheat and winter wheat Bill and Alibaba) their high percentage share. To the contrary, in triticale this share of HMW was very low in ecological cultivation 6.0% and it was 7.6% in intensive cultivation. Figs 1a, b bring differences between ecological and intensive farming of triticale varieties and electrophoretic spectrum of proteins in the Presto variety. Electrophoretic SDS PAGE of triticale varieties is in Fig. 2. In this aspect triticale is close to the values of rye. The HMW content in rye hybrid varieties in ecological farming was always lower (5.6%) compared to intensive cultivation (8.0%). It was reversely in population varieties. The content of LMW gliadins was in triticale in both systems of cultivation almost the same, percentage content in ecological cultivation in rye hybrid varieties it was almost identical compared to triticale (66 and 65% and 64%). Percentage was lower in intensive cultivation (41.5%). It was similar in rye population varieties 73.4 and 63.5%. When compared with winter wheat varieties the content was 66.6%. The rest of albumins and globulins is ranging in triticale between 27 and 30%. Significant differences were recorded in rye according to varieties and intensity of cultivation. These fractions are higher in hybrid varieties and lower in population varieties.

TKW in triticale did not differ so much by varieties neither by cultivation system (differences were nonsignificant). Similar situation was with rye where it was peculiar that these values were lower in population varieties in intensive cultivation. This peculiarity was recorded earlier. The effect of cultivation system on the structure of proteins and on increase of the content of albumins and globulins in ecological cultivation has been confirmed again.

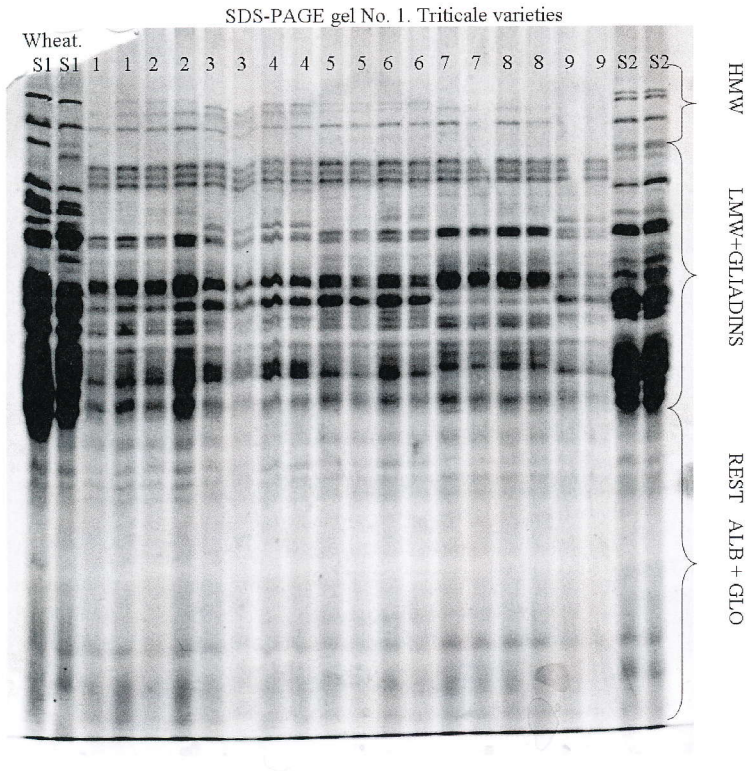

Fig. 2. Elektrophoretic SDS-PAGE Triticale varieties

Standard Spring Wheat Chinese Spring, 1 – Disco ECO, 2 – Disco INT, 3 – Sekundo ECO, 4 – Sekundo INT, 5 – Presto ECO, 6 – Presto INT, 7 – Kolor ECO, 8 – Kolor INT, 9 – Modus ECO, Standard Spring Wheat Marquis

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Kvalita tritikale z ekologického a intenzivního pěstování.

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Tritikale má některé vlastnosti, které jsou výhodné pro ekologické zemědělství. Z pěstitelského hlediska je to menší náročnost na dávky hnojení ve srovnání se stejně výnosnými obilninami. Také nevyžaduje takový rozsah chemické ochrany, což souvisí s kombinací odolnosti proti chorobám pšenice a žita. Je také tolerantní k méně úrodným podmínkám a horší předplodině. Očekávala se však kombinace dobré pekařské jakosti po pšenici a příznivé senzorické vlastnosti žitného chleba. To se však nestalo, prokázala se ale vysoká krmná hodnota tritikale.

Vzhledem k ekologicky příznivým vlastnostem tritikale jsme se v práci zaměřili na hodnocení mlynářské a pekařské kvality tritikale vypěstovaného v ekologickém zemědělství, podle zásad IFOAM a předpisů MZe ČR. S ohledem na výše zmíněnou krmnou kvalitu jsme studovali skladbu bílkovin. Rozbory byly dělány podle ČSN a metod ICC a obsah a frakční skladba bílkovin a její vyhodnocení pomocí SDS PAGE elektroforetické analýzy zásobních bílkovin.

Při hodnocení mlynářské a pekařské kvality se potvrdila u intenzivního i ekologického pěstování nevhodnost současných odrůd tritikale k pekařskému využití – k přípravě kynutých těst. Jakostní ukazatele však nevylučují možnost využití tritikale k řadě dietních a pečivárenských výrobků.

U tritikale z ekologického pěstování byla zjištěna vyšší hmotnost 1 000 zrn, poměrně vyrovnaná objemová hmotnost, ale nižší obsah bílkovin v zrnu. Projevovaly se velké ročníkové rozdíly, např. u čísla poklesu. U tohoto znaku vynikala odrůda Sekundo vysokými hodnotami v intenzivním i ekologickém pěstování. Podobně tomu bylo u sedimentačních testů, kde nebyl patrný vliv způsobu pěstování. Obsah maltózy byl vyrovnaný a závislý na místě pěstování.

Z údajů o skladbě a zastoupení bílkovin byl u tritikale zjištěn nejvyšší obsah a zastoupení albuminů a globulinů, a to u ekologického i intenzivního pěstování. U ekologického pěstování se snižoval obsah prolaminů a glutelinů, ale zastoupení albuminů a globulinů bylo nejvyšší. S vyšší intenzitou pěstování se zvyšoval obsah dusíkatých látek a všech frakcí a jejich zastoupení, nejvíce u prolaminů. Při intenzivním pěstování byly hodnoty všech frakcí vyšší i jejich zastoupení, kromě zastoupení albuminů a globulinů. Podobně to bylo i u odrůd žita. S vyšší intenzitou pěstování stoupal sice obsah albuminů a globulinů, ale klesalo jejich zastoupení. Více však stoupal v těchto podmínkách obsah a zastoupení prolaminů a glutelinů. I u odrůd ozimé pšenice se při ekologickém pěstování zvyšovalo zastoupení albuminů a globulinů. V intenzivním pěstování se však zvyšovalo zastoupení prolaminů a glutelinů. To se potvrzuje i při kvantitativním vyhodnocení SDS-PAGE elektroforetické analýzy zásobních bílkovin, kdy při ekologickém pěstování jsou vysokomolekulární HMW skupiny nižší, podobně u žita odrůd hybridů, ale u odrůd populace je to opačně, což budeme dále zkoumat. U nízkomolekulárních skupin LMW jsou průměrné hodnoty u tritikale téměř stejné, u žita jsou při intenzivním pěstování nižší. Zbytkové albuminy a globuliny jsou vyšší u ekologického pěstování podobně i u žita odrůd hybridů. Opačně je to u žita odrůd populace. Prokázalo se, že ekologický způsob pěstování nezlepšuje pekařskou jakost, ale má vliv na skladbu bílkovin, převážně na vyšší obsah rozpustných frakcí bílkovin – albuminů a globulinů, které jsou nutričně hodnotnější. To může podmiňovat lepší krmnou hodnotu tritikale, která byla již dříve prokázána. Výnosy tritikale z ekologického pěstování činily 88 % výnosů z intenzivního pěstování, což byl nejmenší rozdíl při srovnání s ostatními obilními druhy pěstovanými v ekologickém zemědělství a intenzivním zemědělství.

tritikale; ekologické zemědělství a pěstování; kvalita pekařská; skladba bílkovin

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