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AFFECT THE PRESENCE OF 1B/1R TRANSLOCATION THE NUTRITIONAL VALUE OF WHEAT (*TRITICUM AESTIVUM*)

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Introduction and review of the literature

Cereals in feed ration are, beside a basic source of energy, an important source of proteins as well (Zeman et al. 2003). In animal nutrition it is necessary to calculate with lower nutritional value of wheat proteins in context of lower content of easier digestible albumin and globulin fraction and totally lower content of essential amino acids lysine, threonine, tryptophane and sulfuric amino acids (methionine, cysteine) especially in gluten storage protein (gliadins and glutenins) of grain (Henry, Kettlewell 1997). Kasarda et al. (1976) classified wheat proteins soluble in dilute salt solutions (albumins and globulins) as cytoplasmatic proteins. These “soluble” proteins differ distinctly in their amino acid (AA) composition from the gluten storage proteins and are nutritionally important because the essential AAs amount about 45% of total AAs content.

Because of its agronomic benefits (yield increase, rusts and powdery mildew resistance) the chromosome 1R of rye (*Secale cereale* L.) has been widely used in wheat (*Triticum aestivum* L.) breeding, essentially in the form of the Robertsonian translocation 1B/1R. Several hundreds of wheat cultivars are known to possess this translocated chromosome and many others will bear it unrecognized (Rabinovich 1998). More than one tenth of wheat varieties currently registered in the Czech Republic bears this 1B/1R translocation and, in connection with their lower bread making quality (Bartoš 1993; Graybosch 2001), they are predominately used for livestock feeding.

The relationships between wheat varieties and their feeding values is not investigated and published frequently in comparison with technological (bread making) quality. For example, there were published wheat variety experiments with rats, broilers and pigs in the eighties and nineties. All results referred to variety differences on feeding value (Heger et al. 1989, Fuller et al. 1989; Annison, 1991). The recent work of Pirgozliev et al (2003) tested select grain parameters in 23 wheat varieties in relation to true metabolisation energy (AME_N) obtained from broiler feeding test. On the basis of calculated step regression, the highest signification for explanation of AME_N variability was confirmed for starch, protein and fat content in grains.

This submitted study still represents only part of the wider research focused on determination of wheat grain properties and parameters with higher relation to feeding value for monogastric animals (poultry and pigs). The object of this part was aimed at effect of 1B/1R translocation as well as the impact of selected chemical and technological characteristics of wheat grain on biological parameters of model feeding test.

Material and Methods

A set of 80 doubled haploid (DH) wheat lines was developed from the crossing of wheat cultivar Šárka with advanced line UH 410 (donor of 1B/1R translocation) in the Department of Molecular Biology of CRI Prague. A set of selected 18 DH wheat lines with a higher agronomical potential and according to the presence or absence of allele Gli 1B3 characterizing 1B/1R translocation was subsequently divided into two numerically comparable sub-sets (8 lines with 1B/1R translocation and 10 lines without the translocation). Biological testing performed in accredited station CUA Prague was based on balance and growth experiments with model animals – male laboratory rat (*Rattus norvegicus*) of out-bred race Wistar.

Growth and balance experiments *in vivo* were carried out according to the methodology by Heger et al. (1989) with minimum 10 animals in every group and with the period of 25 days (for growth exp.) and 28 days (for balance exp.) respectively. The experimental diet contained ground grains of the tested wheat samples (as the sole source of protein) in suboptimal level of a 10% protein ratio in whole diet. vitamin

The following parameters were measured: Protein efficiency ratio - (PER) in growth experiments**,** biological value of proteins (BV), Net Protein Utilization (NPU) and coefficient of protein digestibility (CPD) in balance experiments. Nitrogen balance (NB) is the expression of the difference of nitrogen accepted and excreted by excrements (faeces and urine).

On the basis of evaluated chemical and technological parameters transformed by reason of year impact, there was a combination of parameters searched as having the best ability to predict growth parameter PER(trans). An obtained significant regression equation for prediction of transformed parameter PER (see below) had a total correlation R = 0.48, measurement error = 0.14 and statistical significance = 0.013.

PER(trans)=1.62-0.50*Gli-0.46*TotalGlu+0.33*Rel.Viscosity+0.19*W.gluten-0.18*Fat

Results and their discussion

In spite of similar techno-chemical parameters of parental components, published in our previous paper (Dvořáček et al. 2006), there were detected higher significant differences of albumin+globulin fraction and its proportion in crude protein and certain technological parameters (Zeleny sedimentation, PSI, relative viscosity) among particular DH lines. These differences reflected tighter genetic linkage in comparison with other characteristics. Strong genetic conditionality of the parameters PSI and relative viscosity also proved Martinant et al. (1999) and Greffeuille (2006). Significant differences among DH lines were also found in the contents of total and storage proteins, which had a dominant impact on the variability of technological properties like the Zeleny sedimentation test, wet gluten content and GI, as mentioned above. Statistically nonsignificant differences among lines were detected on the contrary in contents of both amino acids (Lys and Met), determined level of GE, content of crude fat, and NFE.

Significant differences in parameters of feeding tests were also noted in particular DH lines. The highest parameters of balance test were determined in the line 136 (without 1B/1R translocation), and on the contrary the lowest values showed the line 112 (with the translocation). Despite a non-significant influence of the translocation on growth of PER parameter, the first three lines with the highest value of this parameter in growing test (110, 174 and 126) showed the presence of 1B/1R translocation. On the other hand the lowest weight gain was recorded in non-translocated line 163. Thus, these results also confirmed equivocation of this factor on the level of feeding tests described by McCracken (2001) and McCann et al. (2006).

An interesting fact brought a comparison of effects of albumins and globulins and storage proteins on growth and balance parameters. Whereas an increase of proportion of albumin+globulin fraction and simultaneous decrease of gluten storage proteins (gliadins and glutenins) evoked an increase of PER, the effect of these protein fractions on balance experiments was the opposite. The reasons for these findings can be explained only hypothetically. In suboptimal levels of protein content in feeding rations we can expect a limiting position in any of the essential amino acids which are deposited mainly in albumin and globulin fraction. For instance, Wrighly and Bietz (1988) indicated a 5 – 7 times higher content of lysine in albumin and globulin fraction. So, in the lines having lower proportion of albumin+globulin fraction, the energy requirement for nitrogen retention increases in dependence on growth of less valuable grain storage proteins.

In contrast to published findings, there was also confirmed a positive effect of relative viscosity. The last two parameters (wet gluten and crude fat) did not have a strong influence on PER modification because of their low partial significance and index coefficient in the equation.

Balance and growth characteristics of feeding test of wheat DH lines (2004 – 2007)

DH Line / Parameters	1B/1R translocation	CPD	BV	NPU	PER
110	**Y**	**84.70**^{cde}	**58.18**^{ab}	**50.59**^{abc}	**1.37**^{d}
112	**Y**	**79.50**^{a}	**50.90**^{a}	**42.85**^{a}	**1.19**^{abcd}
119	**Y**	**82.37**^{abc}	**57.38**^{ab}	**49.07**^{ab}	**1.13**^{abcd}
121	**N**	**81.13**^{ab}	**64.14**^{bcd}	**54.26**^{bcd}	**1.16**^{abcd}
126	**Y**	**83.32**b^{cd}	**63.64**^{bcd}	**55.58**^{bcd}	**1.30**^{bcd}
131	**N**	**84.77**^{cde}	**66.56**^{bcd}	**58.14**^{bcd}	**1.20**^{abcd}
136	**N**	**86.90**^{e}	**71.48**^{d}	**64.34**^{d}	**1.27**^{bcd}
139	**Y**	**86.81**^{e}	**61.65**^{abcd}	**54.94**^{bcd}	**1.03**^{ab}
144	**N**	**84.05**^{bcde}	**66.84**^{bcd}	**57.85**^{bcd}	**1.23**^{abcd}
146	**N**	**84.74**^{bcde}	**65.90**^{bcd}	**57.42**^{bcd}	**1.20**^{abcd}
157	**Y**	**86.02**^{de}	**68.04**^{bcd}	**60.61**^{cd}	**1.29**^{bcd}
159	**N**	**85.91**^{cde}	**67.84**^{bcd}	**59.94**^{bcd}	**1.21**^{abcd}
163	**N**	**85.41**^{cde}	**58.04**^{ab}	**51.08**^{abc}	**0.96**^{a}
164	**Y**	**86.09**^{de}	**63.95**^{bcd}	**56.60**^{bcd}	**1.12**^{abcd}
167	**N**	**85.55**^{cde}	**63.47**^{bcd}	**55.47**^{bcd}	**1.24**^{bcd}
171	**N**	**86.09**^{de}	**67.88**^{bcd}	**60.37**^{cd}	**1.09**^{abc}
174	**Y**	**84.98**^{cde}	**59.71**^{abc}	**52.31**^{abc}	**1.33**^{cd}
176	**N**	**85.07**^{cde}	**63.14**^{bcd}	**55.67**^{bcd}	**1.20**^{abcd}
Nela-standard var.		**84.22**^{bcde}	**65.15**^{bcd}	**56.41**^{bcd}	**1.10**^{abcd}
Šárka-standard var.		**83.58**^{bcde}	**69.37**^{cd}	**59.84**^{cd}	**1.31**^{cd}

Translocation Y	**Y**	**84.25**[a]	**60.84**[a]	**53.20**[a]	**1.20**[a]
Translocation N	**N**	**84.97**[a]	**65.09**[b]	**57.07**[b]	**1.19**[a]
Year	2004	**85.73**[b]	**62.74**[b]	**55.82**[b]	**0.98**[a]
	2005	**86.27**[b]	**71.05**[c]	**62.85**[c]	**0.98**[a]
	2006	**81.86**[a]	**58.78**[a]	**49.70**[a]	**1.58**[b]

Values of parameters marked by the different letters are significantly different at $p \leq 0.05$

Resume

Finally, we can conclude that relationships of evaluated grain characters to the results of the feeding tests were not fully unambiguous. Presence of 1B/1R translocation significantly decreased the values of balance parameters (NPU and BV). Nevertheless, a similar effect of the translocation was not proven in growing test (PER). Lower, but a significantly positive correlation of albumin+globulin fraction and a negative correlation of storage protein with PER parameter were confirmed by correlation analysis. Obtained correlation coefficients in frequently declared characteristics (grain hardiness and relative viscosity) with relation to feeding value PER were low and not statistically significant. It is possible to assume that individual ratios between albumins+globulins and gluten protein composition of grains influenced values of PER more significantly than the presence of 1B/1R translocation which is only one of many genetic factors participating in protein composition of grain.