

SHORT COMMUNICATION

NUTRITION AND DIETETIC EFFECT OF WHEAT (*TRITICUM AESTIVUM*) FROM CONVENTIONAL AND ECOLOGICAL FARMING*

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Ecological agriculture is quickly evolving in conditions of the Czech Republic. In the present time permanent herbage are largely spread. They occupy 6% of agricultural soil. It is possible to count with expansion on arable soil; where beside production of biofoods production of feedstuffs for monogastry comes about. That is why this study shows nutritional values cultivated grains this way like actual. In our tests ratified differences in the feeding value of concrete varieties as well as differences among monitored locality (ecological versus conventional) were investigated. As an unseasonably to feeding purpose shows the variety with an elite food quality, on the contrary, variety unseasonably for baker utilization had good feeding qualities. The tests further significantly show higher nutritive characteristics feeding values diets of ecologically cultivated wheat in the values of daily gains of animals (*Rattus rattus* var. *norvegicus*), feed conversion, conditions PER, BV, NPU and NB. The cause may be higher content of protoplasmic protein of grains, so and better ratio to store protein especially to insoluble fraction gliadin and glutenin. Higher content of soluble albumins and globulins cohere with higher content of essential amino-acid.

ecological agriculture; nutritive value; wheat;

INTRODUCTION

The substantial part of wheat production has been grown with the aim to attain the grocery store quality and increase the purchase price this way. If the wheat fails to be sold as the grocery it is transferred to fodder supply category with worse nutrition parameters. At the present time there is no exact definition of the fodder wheat. Problem of the fodder wheat quality was defined by Petr (2000) as all the wheat varieties characterized by lower content of insoluble fractions (prolamine, glutenin) and higher content of soluble fractions of albumin and globulin, with a high protein efficiency ratio (PER). Nevertheless, it seems necessary to say that there is no quality standard in the Czech Republic whose quality criteria would classify fodder cereals uniquely. Cereal fodder values lack the grade of systematic study known from various analyses of the grocery cereals.

Czech ecological agriculture has been developing since 1990. There were 810 eco-enterprises registered before the end 2003. They are farming on the area of 2549.95 km², which represents 5.97 per cent of the agricultural land.

The most significant difference of quality in the wheat grown conventionally and that grown ecologically consists in different ratio of proto-plasmatic proteins (albu-

mins and globulins) to stored proteins (prolamins, glutenins). Many published papers, e.g. Petr, Škeřík (1999), Petr et al. (2004), Stehlíková (1999), Prugar (2000), Vaculová (1999), confirm that the ecological production shows a more convenient spectrum of protein composition. This is characterized by a greater share of genetically fixed proto-plasmatic proteins. The conventional farming with nitrogen fertilizers is studied in increased reserved proteins (a reaction to farming technology) and higher alimentary quality of grain.

MATERIAL AND METHOD

A nutritional value of four wheat varieties and three localities was tested in growth and balance experiments on laboratory rats (strain Wistar from the SPF – specific pathogen free). In diets the mentioned varieties of wheat were the only source of nitrogen (in fraction equivalent to the content of 6.25 × 10 or 9 per cent). The protein level in experimental diets was intentionally chosen at the sub optimum limit so that the differences in animal response concerning the quality of grain protein component could be detected. Energy value in diets was preserved at the constant level as well as the content of the

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minerals (macro- and micro-elements), vitamins and soy oil.

Biological testing performed in accredited station CUA Prague was based on balance and growth experiments with model animals – male laboratory sewer-rat (*Rattus norvegicus*) of out-bred race Wistar. The animals were from the State Breeding Farm of BioTest Konárovice s.r.o. All the animals used were of the age of 21 days and their body mass was 55 ± 3 g. They were bred individually and grouped by the principle of maximal similarity.

Growth and balance experiments in vivo were carried out according to the methodology by Heger et al. (1990) with minimum number 12 of animals in every group. The variables measured were as follows: biological value of proteins (BV), nett protein utilization (NPU) auxiliary parameters as nitrogen balance (NB), metabolism loss of nitrogen (Nmet), endogen loss of nitrogen (Nend) and maintenance requirement of nitrogen in animals (NEB). Each biological testing was realized after the following plan: After 4-day acclimatization the balance experiment lasted 4 days and for growth experiments was 4 day acclimatization and 21-day experiment.

Basic chemical analysis was performed twice in each sample. The following parameters were determined: content of dry matter (DM), amount of nitrogen, fat, fiber matter and ash substance. Knowing those the content of water, both nitrogen and nitrogen free extract (NFE) and organic nutriment (OM) can be calculated. Further, the energy value or gross energy (GE) was determined calorimetrically (Kacerovský et al., 1990).

Results of analyses were evaluated by means of statistical methods (ANOVA = analysis of variance).

Characteristics of localities used:

UHRÍNĚVES: type of growing: ecological (certified for ecology experiments and instructions issued by international organization for ecology agriculture IFOAM – the International Federation of Organic Agriculture Movement), production region: sugar beet, soil type: brown soil, soil: clay loam soil.

NECHANICE: type of growing: conventional, production region: sugar beet, soil type: brow soil, soil sort: loam soil, fertilizer type: 110 kg N.ha^{-1} , chemical treatment: Starane 250 EC 0.6 l/ha, MCPA Stefes 0.8 l/ha, Retacel 2 l/ha + Tilt 250 EC 0.5 l/ha, Alto Combi 0.6 l/ha.

LÍPA: type of growing: conventional, production region: cereal-growing, soil type: brown soil, soil sort: sandy-loam soil, fertilizer type: $100 \text{ kg N.ha}^{-1} + 80 \text{ kg K.ha}^{-1}$, chemical treatment: Stomp 330 – 5 l/ha, Falcon 460 EC – 0.4 l/ha, Tango Super 1 l/ha.

Rainfall and temperature characteristics:

Distribution of rainfall and temperature in the vegetation and other soil-climatic influence, which play a dominant role in production and qualities of grains, was regularly monitored. Months May and June, those are laying from precipitation amount behind important yield element, on single standpoint shows the difference. In ecological standpoint Uhříněves reached bimonthly precipi-

tation 139.2 mm, while on conventional standpoint are the levels of 67.2% (Nechanice) were achieved, respectively the levels 115.7% (Lípa) hereof total temperature course. June, which reflects in the total quantity nitrogen matters on grains, was not on locations to excess different (Uhříněves 15.5 °C, Nechanice 15.2 °C, Lípa 13.7 °C). Content of nitrogen matters was determinant so above all variety and agricultural engineering.

Characteristics of the varieties used:

SULAMIT is a half-late baker's trade variety. Its baker quality belongs to the category E – elite quality.

SEMPER is a variety of B/C quality. It has parameters enabling the bakery as well as bread and pastry use. These features allow denominating the Semper variety as the wheat with the universal range of use.

ESTICA due to its excellent health constitution can be recommended for growing in low input systems, at areas of hygienic protection of water sources as well as for ecological agriculture. Estica is a half-late fodder wheat variety (quality mark C) of the middle growth.

CONTRA is a half-late up to late feeding variety with a smaller grain, and poor baking quality (class C).

RESULTS AND DISCUSSION

The daily increase of body mass in animals fed with the variety Estica was approximately by 15 per cent greater than in animals fed with the elite baker quality variety Sulamit ($P \leq 0.05$). This experience was confirmed at both conventional stations. This is obviously connected to different amounts of insoluble (prolamin, glutenin) and soluble (albumin, globulin) protein fractions in the fodder varieties, which even in spite of intensive agro-technical intervening have preserved their fodder profile (H ub í k, 2000).

The relative difference of growth intensity between the ecological station Uhříněves and the conventional station Nechanice was 14 per cent ($P \leq 0.5$). Even greater decrease was registered between the ecological Uhříněves and the conventional Lípa (by 121 per cent) due to a complex of influences, such as different production classification, soil and climatic conditions, different agro-technical operations ($P \leq 0.5$). Intensive agriculture increased the protein content in grain but, at the same time, it caused its worse fodder quality. This statement was confirmed by Steh lí k o v á (1999) and S v o b o d o v á (2000).

The differences between individual varieties at the ecological locality Uhříněves verified the fodder quality of Estica and Contra. The daily body mass increments with the elite grocery wheat Sulamit were by about 16 per cent lower than those with Estica and Contra, which are of the quality C. This was proved also on the general level of all localities and varieties, where the worst index of the body mass increment belonged to the grocery variety Sulamit (2.3 g a day).

These results show that determination of the protein quality of wheat (reflected in quality marks) does not de-

pend on the agro-technical intensity. The fodder varieties perform as fodder ones, no matter whether grown ecologically or conventionally. This was also a conclusion of Petr (2000).

Higher nutrition value of grain (its protein quality) from the ecological station can be proved by comparison of the results in all varieties grown in conventional localities. The positive effect of ecological growing can be seen from the following differences:

Estica – 11 per cent, Sulamit – 7 per cent, Semper – 16 per cent, Contra – 13 per cent.

The worst **fodder conversion** was recorded in the variety Sulamit. The difference between the fodder variety Estica and Sulamit was 25 per cent ($P \leq 0.01$). Statistically significant difference was ascertained in pairs Sulamit/Semper, Sulamit/Contra, Estica/Semper (on the significance level of $P \leq 0.05$). The best food conversion was obtained in wheat varieties grown in the ecological locality Uhříněves, without use of any fertilizer, pesticides etc. Lower content of nitrogen compound is connected with the greater presence of protoplasmatic proteins (Prugar, 2000; Petr, Škeřík, 1999; Petr et al., 2004; Stehlíková, 1999). This is reflected in favorable fodder conversion (the difference against conventional stations is 35 per cent ($P \leq 0.01$)). Statistically significant difference ($P \leq 0.05$) was ascertained among all localities. These results were confirmed also by Svobodová (2000) and Stehlíková (1999).

When the ecological locality is viewed more closely, also fodder varieties Estica and Contra came over Sulamit (the difference was 35 per cent). This reprints quality parameters of individual varieties (better conversion in fodder varieties in comparison with that in grocery one) in all kinds of growing. The fodder conversion from ecological station compared with the conventional localities gives a higher nutrition value (17 per cent lower than the average conversion of conventional localities, in Estica and Semper 17 per cent, in Sulamit 10 per cent and in Contra 23 per cent). It is caused by greater fraction of albumins and globulin due to improved amino-acidic compounding.

Protein efficiency ratio (i.e. efficiency of the protein unit in body mass increment of animals) attained the maximum values in the variety Estica (quality grade C), the worst results were obtained with the variety Sulamit (quality grade E). The difference between these two extremes was about 20 per cent. The next fodder variety Contra compared with the elite grocery Sulamit showed the difference of 16 per cent ($P \leq 0.05$). This can be explained by different content of soluble protein fractions (albumin, globulin), i.e. by higher nutrition value of fodder varieties (quality grade C).

According to former results obtained by Svobodová (2000) and Stehlíková (1999) the ecological locality proved to be most advantageous from the standpoint of the ratio PER. The difference between the ecological locality and the conventional ones was about 30 per cent ($P \leq 0.01$). In more detail, the maxim ratio PER showed the fodder varieties Estica and Contra.

This way, both the varieties confirmed the advantageous presence of proto-plasmatic proteins closely related to better protein utilization Heger et al. (1990), Hanišová (1999).

Nutritional values of the grain from ecological production were compared with the grain from conventional localities. The protein production ratio was increased in the ecologically grown grain as follows: in Estica by 23 per cent, in Sulamit by 17 per cent, in Contra by 29 per cent and in Semper by 25 per cent. The ecological growing without use of nitrogen fertilizers (that increase the content of less valuable prolamin fraction) attains higher nutritional values Prugar (2000).

The results are presented in Table 1.

When the basic nutrition parameters in all tested varieties had been determined, the main attention (balance experiment) was focused on the so-called fodder varieties Estica and Contra, which can be successfully used in ecological farming and animal production. The results are presented in Table 2.

The **nitrogen balance** represents percentage of nitrogen stored in the animal body from the completely accepted nitrogen amount. This is a very important parameter for evaluating the nutrition effect of the protein diet. It showed differences between the wheat fodder varieties, and, in the results obtained, the growing locality was respected too. The difference between Estica and Contra was 18 per cent (at the ecological station it was 16 per cent). Grain from the conventional locality Nechanice gave higher values than that from the ecological farming Uhříněves (by 20 per cent; $P \leq 0.05$). The reason could be seen in higher ratio of stored proteins (glutenins and gliadins) characterized by easier digestibility, but worse nutrition characteristics. The difference of 33 per cent between both the stations (Nechanice and Lípa) is surprising ($P \leq 0.05$). In comparison with the ecological station with the total of the varieties in conventional localities the difference shrinks to 3 per cent in Estica and 1 per cent in Contra, which is negligible.

Biological value of proteins as a ratio of nitrogen stored in the body from the amount of the totally accepted nitrogen was different between varieties Estica and Contra (18 per cent in all localities and 25 per cent at the ecological locality), though both of them belong to the fodder wheat, quality C. Higher biological values of proteins, i.e. higher digestibility and better utilization of proteins for proteosynthesis, were obtained with Estica ($P \leq 0.05$). There was a significant difference between the ecological station and conventional localities (about 12 per cent) too. This was found also in an earlier study of Stehlíková (1999), which offered a view of the ratio of albumins and globulins related to supply proteins of the grain.

In evaluation the nutritional value of the ecological production the comparison between the total set of varieties and localities and the corresponding wheat varieties grew ecologically. The differences between the protein biological values were 14 per cent in Estica and 3 per cent in Contra, in favor of the ecological grain. This con-

Table 1. The daily increase of body mass, food conversion and protein efficiency ratio of experimental varieties and localities

Parameters	Daily increase of body mass	Food conversion	Protein efficiency ratio
	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
Varieties (from all localities)			
Estica	2.7 ± 0.07 ^a	4.8 ± 0.16 ^{a,A}	2.2 ± 0.10 ^{aA}
Sulamit	2.3 ± 0.05 ^b	6.0 ± 0.11 ^{bb}	1.8 ± 0.06 ^{bb}
Contra	2.6 ± 0.08 ^{ab}	5.2 ± 0.22 ^c	2.1 ± 0.12 ^a
Semper	2.4 ± 0.08 ^{ab}	5.4 ± 0.17 ^{bc}	2.0 ± 0.09 ^{ab}
Localities (all experimental varieties)			
Nechanice	2.4 ± 0.04 ^a	5.5 ± 0.10 ^a	1.8 ± 0.03 ^{aA}
Lípa	2.2 ± 0.04 ^a	6.1 ± 0.11 ^{bb}	1.7 ± 0.06 ^{aA}
Uhříněves	2.8 ± 0.06 ^b	4.5 ± 0.12 ^{cc}	2.5 ± 0.06 ^{bb}
Varieties from ecological locality Uhříněves			
Estica	3.00 ± 0.11	4.0 ± 0.11	2.7 ± 0.07
Sulamit	2.5 ± 0.13	5.4 ± 0.08	2.1 ± 0.03
Contra	3.00 ± 0.07	4.0 ± 0.07	2.7 ± 0.04
Semper	2.8 ± 0.05	4.5 ± 0.05	2.5 ± 0.03

ANOVA: a, b – $P \leq 0.05$; A, B – $P \leq 0.01$

Table 2. The nitrogen balance, biological value of proteins and pure utilization of nitrogen of experimental varieties and localities

Parameters	Nitrogen balance	Biological value of protein	Nett protein utilisation
	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
Varieties (from all localities)			
Estica	71.0 ± 3.79	54.0 ± 0.99 ^a	48.2 ± 2.99
Contra	58.5 ± 3.59	44.5 ± 1.09 ^b	44.5 ± 1.16
Localities (all experimental varieties)			
Nechanice	78.3 ± 4.17 ^a	46.9 ± 1.20 ^a	40.4 ± 2.98 ^a
Lípa	52.7 ± 3.45 ^b	47.3 ± 2.00 ^b	46.2 ± 2.22 ^{ab}
Uhříněves	63.2 ± 3.80 ^b	53.7 ± 2.88 ^b	52.6 ± 2.09 ^b
Varieties from ecological locality Uhříněves			
Estica	78.3 ± 4.17 ^a	61.4 ± 1.82	57.3 ± 2.29
Contra	52.7 ± 3.45 ^b	46.0 ± 2.92	47.8 ± 2.25

ANOVA: a, b – $P \leq 0.05$

firming the positive effect of ecological production on the grain amino-acidic composition that determines its higher nutritional value. The same opinions were published by Storey et al. (1993) and Prugar (2000).

Nett protein utilization as the ratio of nitrogen stored in the body and the totally accepted nitrogen was different in relation to both varieties and localities. The difference between the fodder varieties Estica and Contra was 8 per cent, at the ecological station it was 12 per cent. This indicates a higher presence of better digestible and utilizable nitrogen compounds (proto-plasmatic proteins of grain). The highest values of protein utilization, 52.6 per cent, were attained at the ecological locality Uhříněves. The difference between Uhříněves and Nechanice was 23 per cent ($P \leq 0.05$); and between Uhříněves and Lípa it was 12 per cent. This can be ex-

plained by more favorable ratio of proto-plasmatic and reserve proteins in grain as a consequence of eliminating the nitrogen fertilization (Stehlíková, 1999).

The last parameter of grain nutritional characteristics showed (in comparison of the conventional number of varieties to those growing at ecological station): the difference 19 per cent in Estica and 7 per cent in Contra in favor of ecological growing. This proves the hypothesis that the grain produced ecologically attains higher fodder values due to greater presence of proto-plasmatic proteins (albumins and globulins) and this way also their improved proportion to stored proteins. This was stated also by Petr and Škeřík (1999).

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Nutriční a dietetické působení pšenice (*Triticum aestivum*) z ekologického a konvenčního pěstování.

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Ekologické zemědělství se v podmínkách ČR rychle rozvíjí. V současné době ale jde převážně o trvalé travní porosty. Zaujímají 6 % zemědělské půdy. Počítá se s rozšířením na orné půdě, kde vedle produkce biopotravin půjde i o produkci krmiv pro monogastry. Proto se jeví studium nutriční hodnoty takto vypěstovaného zrna jako aktuální.

V našich pokusech se potvrdily odrůdové rozdíly v krmné hodnotě stejně jako rozdíly mezi sledovanými lokalitami (ekologická versus konvenční). Jako nevhodné ke krmným účelům se ukázaly odrůdy s elitní potravinářskou jakostí, naopak odrůdy nevhodné pro pekařské využití měly dobrou krmnou kvalitu. Pokusy dále signifikantně ukázaly vyšší nutriční parametry krmné hodnoty diet ekologicky vypěstovaných pšenic v parametrech denního přírůstku modelových zvířat, konverze krmiva, poměru PER (bílkovinný produkční poměr), BHB (biologická hodnota bílkovin), NPU (netto – využití proteinu) a NB (bilance dusíku).

Příčinou může být vyšší obsah protoplazmatických bílkovin zrna, a tím i lepší poměr k zásobním bílkovinám zejména k nerozpustné frakci gliadinové a gluteninové. Vyšší obsah rozpustných albuminů a globulinů souvisí s vyšším obsahem esenciálních aminokyselin.

ekologické zemědělství; nutriční hodnota; pšenice

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