Connection of Protein and Amino Acid Content of Different Winter Wheat Varieties

Zoltán MEZEI [1(✉)]
Ágnes PONGRÁCZNÉ BARANCSI [2]
Zoltán GYŐRI [3]
János CSAPÓ [3, 4]

Summary

The crude protein content amino acid content and amino acid composition of four forage and milling quality winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') from their samples from five following years (2003, 2004, 2005, 2006 and 2007) were analysed.

The crude protein content of the examined 20 samples of winter wheat varieties were between 11.2 – 14.6 % on dry matter base.

We found that quantity of essential and non essential amino acids rose with increase in crude protein content. The dynamics of quantitative growth was significantly different. We established that, when crude protein content increases for 0.1 %, the essential amino acid content rises by 0.3 g and the non essential amino acid content increases by more than its double, 0.67 g.

By examination of amino acid composition of the protein in relation to crude protein content we found that the crude protein content increased the rate of the non essential amino acids, while the rate of essential amino acids decreased.

To confirm these facts, we analysed the quantity of the limiting amino acid of wheat (lysine) in term of the protein content. We found that, as all the essential amino acids, the quantity of the lysine decreased with increase in crude protein content.

To determine the biological value we used the data of ideal food, worked out by the FAO/WHO, which contents the essential amino acids in optimal quality and quantity. We established that as crude protein content increased, the biological value of the protein decreased.

Key words

winter wheat, crude protein content, amino acid composition, essential amino acids, biological value

[1] Hajdúsági Gabonaipari Inc., 13. Széchenyi Str. H-4025 Debrecen, Hungary
✉ e-mail: mezoli@citromail.hu
[2] Technical and Agriculture Faculity Szolnok Collage, 1. Petőfi Str. H-5400 Mezőtúr, Hungary
[3] University of Debrecen, Institute of Food Science, Quality Assurence and Microbiology, Faculty of Agronomy, 138. Böszörményi Str. H-4032 Debrecen, Hungary
[4] University of Kaposvár Institute of Chemistry and Biochemistry, Faculty of Animal Sciences, 40. Guba Sándor Str. H-7400 Kaposvár, Hungary

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Introduction

The more effective management of the available fodder-, and feedprotein of the farms – or the country – requires that the appreciation of proteins should play a bigger role in the chemical analysis, biological tests and in the practice (Hajas, 1981).

Increasing the dose of fertilizer causes the increasing of crude protein content of the wheat (Tanács el al., 1995). Izsáki (2006) established that with increasing dose of nitrogen fertilizer, quantity of some amino acids rose by 7-20 %.

Győri and Bocz (1982) analysed the quality of Jubilejnaja-50 winter wheat variety, under the effect of fertilization. They found that the effect of fertilization increased the protein content, and changed the protein composition of the wheat. Test of Sonntag and Michael (1973) proved that all the factors, which affect increase of the crude protein content of the wheat, cause the decrease of the valuable components. The increase of the crude protein content in the wheat grain causes the change of different rate of proteins (Pepó and Győri, 2007).

According to Block and Michael's (1946) "limiting amino acid theory", the utilization of the food proteins, is determined by the least quantity of essential amino acid of the protein.

Withacre (1985) composed regression equations to estimate the lysine-, metionin- and cystine content of wheat.

Looking over the scientific results, the most authors agree with the fact that the increasing crude protein content causes the decrease of the more valuable components (Balogh et al., 2007), so the increase of crude protein content affects the decrease of essential amino acid content and the biological value of the protein.

Our investigations aimed to find out what relation is between crude protein content and essential and non essential amino acid content and the biological value of the wheat protein.

Materials and methods

Analysed winter wheat samples were from Hungary, Jász-Nagykun-Szolnok County, University of Debrecen and Agricultural Centre Karcag Research Site. All the examined varieties are hard red winter wheat ones. The varieties examined were: 'Magor', 'Hunor', 'Róna' and 'Kondor'. We analysed 20 representative samples of the four winter wheat varieties, from 2003 to 2007.

Laboratory tests were conducted in the Analytical Laboratory of University of Kaposvár and Central Laboratory of the University of Debrecen, Centre of Agricultural Sciences. We analysed the moisture and crude protein content according to MSZ 6830 standard.

The moisture content was determined from 5 g ground material after drying in cupboard at 130 °C for two hours. The protein content was determined by Kjeldahl-method from 1 g ground material after concentrated sulphuric acid destruction and ammonia discharging, with KJELTECH 2300 ANALYZER.

The amino acid composition was determined according to the work of Csapó and Csapóné (1985) and Csapó et al. (1986), with INGOS AAA amino acid analyser by acidic hydrolysis.

We used MORUP- and OLESEN's (1973) biological value to determine the biological values of the wheat samples by their protein composition. This way we compared the amino acid quantity of the sample with data of the reference protein worked out by the FAO/WHO (Table 1).

Biological value = $10^{2.15}$ x Q (lys) $^{0.41}$ x Q (arom) $^{0.60}$ x Q (sulf) $^{0.77}$ x Q (thr) $^{2.41}$ x Q (trp) $^{0.21}$

where:

$Q = a/a_{ref}$, a = the certain essential amino acid/total essential amino acid in the examined protein, a_{ref} = the certain essential amino acid/total essential amino acid in the reference protein, arom = aromatic amino acids (tyr, phe), sulf = sulphureous amino acids (cys, met).

The results of the tests were evaluated by 11.5 for Windows and Excel 6.0 for Windows programs, the figures and tables were made by Excel 6.0 for Windows program. In order to more precisely identify the trends in the diagrams, smoothed the average values were indicated and there were also trendlines to illustrate the directions of the changes.

We examined the relations between the quality of crude protein content, amino acid composition and biological value of proteins with linear regression analysis.

Results and discussion

The crude protein content of the examined 20 samples of winter wheat varieties were between 11.2 – 14.6 % on dry matter base. The amino acid content can be analysed in term of 100 g wheat, in this case we can get information about the quantity of amino acids, on the other hand we can analyse the amino acid content in term of 100 g protein, when we can get information about the quality of the wheat protein.

Connection of crude protein and amino acid content in relation to quantity. We found that quantity of essential and non essential amino acids rose with increase in crude protein content. The dynamics of quantitative growth was significantly different. We established that, when crude protein content increase for 0,1%, the essential amino acid content rises by 0.3 g and the non essential amino acid content increases by more than its double, 0.67 g (Figure 1).

Table 1. The amino acid quantity of the reference protein by FAO/WHO (1973)

Essencial amino acid	Trp	Phe + Tyr	Leu	Ile	Thr	Met + Cys	Lys	Val
Reference protein concentration (g/100g)	1.0	6.0	7.0	4.0	4.0	3.5	5.5	5.0

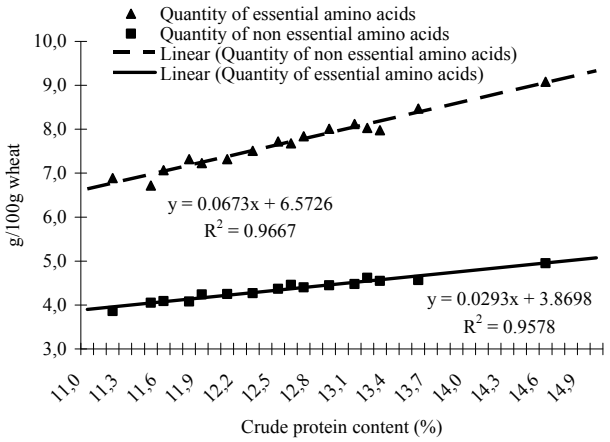

Figure 1. Changes of the quantity of essential and non essential amino acids plotted against crude protein content (Karcag, 2003-2007)

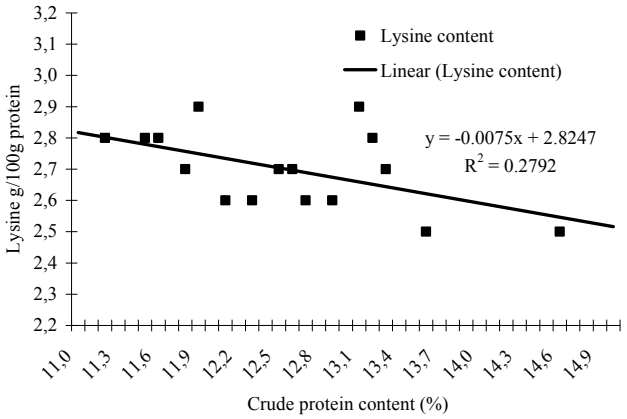

Figure 3. Changes of the lysine content of the wheat protein plotted against crude protein content (Karcag, 2003-2007)

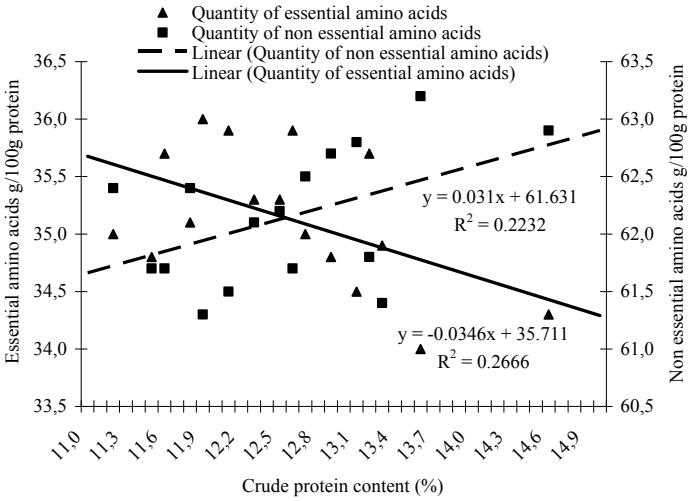

Figure 2. Changes of the essential and non essential amino acids of the protein by crude protein content (Karcag, 2003-2007)

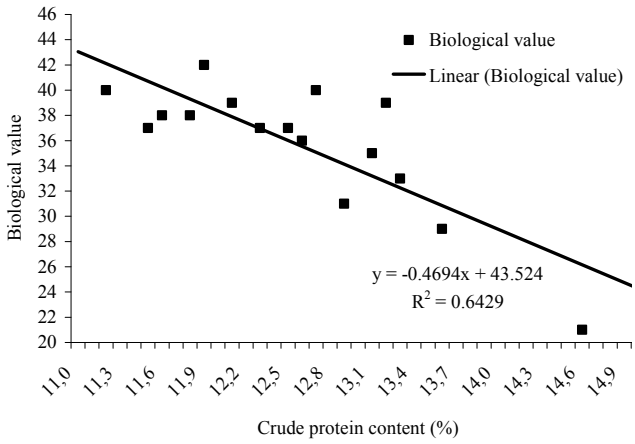

Figure 4. Changes of the biological value of the wheat protein by crude protein content (Karcag, 2003-2007)

Connection of crude protein and amino acid content in relation of quality. By examination of amino acid composition of the protein in relation to crude protein content we found that the crude protein content increased the rate of the non essential amino acids, while the rate of essential amino acids decreased (Figure 2.).

To confirm these facts, we analysed the quantity of the limiting amino acid of wheat (lysine) in term of the protein content. We found that, as all the essential amino acids, the quantity of the lysine decreased with increase in crude protein content (Figure 3).

Connection of crude protein and the biological value. To determine the biological value we used the datas of ideal food, worked out by the FAO/WHO (1973), which contents the essential amino acids in optimal quality and quantity.

We established that as crude protein content increased, the biological value of the protein decreased (Figure 4.).

Conclusions

We established that the quantity of essential and non essential amino acids of the samples of the examined winter wheat varieties rose with increase in crude protein content.

The quantity of essential amino acids in the wheat protein decreased, the same as the quantity of the limiting amino acid, the lysine.

Table 2. The average crude protein, essential amino acid and the non essential amino acid content and biological value of the examined winter wheat varieties

Winter wheat varieties	Crude protein (%)	Amino acid quantity (g/100g wheat)		Amino acid quantity (g/100g protein)		Lysine quantity (g/100g protein)	Biological value
		Essential	Non essential	Essential	Non essential		
Róna	12.04	4.25	7.48	35.70	61.64	2.80	38.10
Kondor	12.40	4.33	7.43	35.42	61.82	2.76	37.70
Magor	12.30	4.32	7.61	35.16	62.26	2.75	36.70
Hunor	13.16	4.51	8.07	34.80	62.32	2.70	28.60

On the other hand, the quantity of non essential amino acids increased with increase in crude protein content, consequently the increasing crude protein content decreased the biological value of the protein (Table 2).

References

Balogh, Á., Hornok, M., Pepó, P. (2007): Study of physiological parameters in sustainable winter wheat (Triticum aestivum L.) production. Cereal Research Communications, 35. 205-208.

Block, R. J., Mitchell, H. H. (1946): The correlation of the amino acid composition of proteins with their nutritive value Nutr. Abstr. Rev., 16. 249-278.

Csapó, J., Csapó-né Kiss, ZS. (1985): Új ioncserés oszlopkromatográfiás módszerek élelmiszerek és takarmányok analízisében. MTA Kémiai Tudományok Osztálya, Budapest, Erdey László díjas pályamunka, 139.

Csapó, J., Csapó, J.-né., Tóth, L.-né (1986): Optimization of hydrolysis at determination of amino acid content in food and feed products. Acta Alimentaria, 1. 3-21.

FAO (WHO) (1973): Energy and protein requirements. Techn. Rep. Serie, 522. Geneva.

Győri, Z., Bocz, E. (1982): Az öntözés és trágyázás hatása Jubilejnaja 50 búzafajta termék minőségére. Növénytermelés, 31. 217-225.

Hajas, P. (1981): A takarmányfehérjék minősítése. Mezőgazdasági kiadó, 3-11.

Izsáki, Z. (2006): A N- és P-ellátottság hatása a kukoricaszem (Zea mays L.) fehérjetartalmára és aminosav-összetételére. Növénytermelés, 55. 3-4.

Pepó, P., Győri, Z. (2007): Amino acid compositions in wheat species with different genomes. Cereal Research Communications, 35. 1685-1699.

Sonntag, Chr., Michel, G. (1973): Einfluss einer späten Stickstoffdüngung auf Eiweissgehalt und Eiweisszuzammensetzung von Körner Konventioneller und Lysinreicher Formen von Mais und Gerste. Acker-u. Pflanzenbau, 138. 116-128.

Tanács, L., Matuz, J., Bartók, T., Gerő, L. (1995): Effect of NPK fertilisation on the individual amino acid content of wheat grain. Cereal Research Communications, 23. 403-409.

Whitacre, M. F. (1985): Amino acid profiles and regression equations of major feed ingredients. Degussa Technical Symposium, 34-57.