COMPARISON OF AMINO ACIDS CONTENTS IN BARLEY AND WHEAT

KOMPARACIJA SADRŽAJA AMINOKISELINA KOD JEČMA I PŠENICE

D. KNEŽEVIĆ*, Nevena ĐUKIĆ, Milomirka MADIĆ***, A. PAUNOVIĆ***, Veselinka ZEČEVIĆ******

**University of Pristina, Serbia*
***University of Kragujevac, Serbia*
****University of Kragujevac, Cacak, Serbia*
*****Economic Society Center for Small Grains DOO, Kragujevac, Serbia*
Corresponding author: Desimir Knežević, e-mail:deskoa@ptt.yu

Summary: *Variability of amino acids composition of 6 barley and 6 wheat divergent genotypes were identified by using method of chromatography. Concentration of identified amino acids was established by method of spectrophotometry. Total concentration of free amino acids was determined by standard curved line for tyrosine while concentration for each amino acid was determined by using of standard curved line for glycine. Qualitative and quantitative analysis of amino acids showed that glutamic acid, proline, threonine, norvaline, tryptophan, were the most present in seeds of analyzed cereal species cultivars. Quantity of free amino acid in wheat varies in the ratio from 35 to 92 mg/ml and in barley from 41 to 81 mg/ml. Concentration of glutamic acid in wheat was 6.5 mg/ml and was higher than contents of other amino acids. In barley cultivars the highest concentration was established for amino acids proline (12.5 mg/ml)*

Sažetak: *Varijabilnost sadržaja aminokiselina kod 6 sorti ječma i 6 divergentnih genotipova pšenice je identifikovana korišćenjem metode hromatogragije. Koncentracija amino kiselina je ustanovljena metodom spektrofotometrije. Ukupna koncentracija slobodnih aminokiselina je odredjivana pomoću standardne krive linije za tirozin, dok je koncentracija pojedinih aminokiselina odredjivana korišćenjemstandardne krive linije za glicin. Kvalitativna i kvantitativna anliza aminokiselina je pokazala da su u semenu ječma i pšenice od slobodnih aminokiselina najzastupljenije: glutaminska kiselina, prolin, treonin, norvalin, triptofan. Kvantitet aminokiselina kod pšenice varira u rasponu od 35-92 mg/ml a kod ispitivanih sorti ječma od 41 do 81 mg/ml. Koncentracija glutaminske kiseline kod pšenice bila je najveća 6.5 mg/ml u poredjenju sa drugim aminokiselinama. Kod sorti ječma najveća koncetracija je ustanovljena za aminokiselinu prolin (12.5 mg/ml).*

Key words*: wheat, barley, nutrition, amino acids*
Ključne reči: *pšenica, ječam, hranljiva vrednost, aminokiseline*

INTRODUCTION

During life time of wheat and barley the products of biosynthesis plants mainly deposited in grain. However, different chemical components of cereals are not uniformly distributed in the grain. Starch is present only in the endosperm, but protein is distributed through all parts of the grain.

The aleurone layer of wheat contains 25 times more minerals than the endosperm while the lipids are generally concentrated in the aleurone and germ. The starch, proteins mostly in endosperm was deposited as well low contents of fat and ash. In average, cereals consist of 12-14 percent water, 65-75 percent carbohydrates, 2-6 percent lipids and 7-12 percent protein.

Cereals are quite similar in grass composition being low in protein and high in carbohydrates. High starch content, typically about 72% of the total dry weight of wheat grain

Lasztity & Lasztity (1990) and a protein content is in ratio of 6-16% (Simmonds, 1981). According to structure a function proteins are complex and express great diversity (proteins of the gluten complex in dough which, through their elastic and flow properties, are of unique value in baking; enzymes, antibodies and hormones are globular proteins which have important physiological functions in plant).

Despite this diversity, all proteins share some basic features. They are high molecular weight molecules which invariably contain carbon, hydrogen, oxygen and nitrogen. Some, though not all, also contain sulphur and a few also contain phosphorus. The basic elements are in the form of amine and carboxyl groups which are linked to carbon atoms to form amino acids. Amino acids are the fundamental units of protein.

The purpose of this investigation was analysis of variability amino acid composition and concentration in different plant species, barley and wheat

MATERIALS AND METHODS

Grain sample of 6 barley cultivar (Novosadski 183, Novosadski 329, Novosadski 293, Novosadski 295, Novosadski 299, Novosadski 307) and 6 wheat (KG-3526/98, KG-35171/94, KG-12, KG-3, KG-3608/2/00, Partizanka), were used for analysis of amino acid contents.

The extraction of amino acids from complex compound of grain (carbohydrates, lipids, inorganic salts etc) was conducted by using 80% of ethanol and sedimentation of dissolved proteins by chloroform (Grujic-Injac, 1962).

Identification of amino-acids has been done by using method of chromatography. The method of spectrophotometry was used for establishing concentration of identified amino acids. Total concentration of free amino acids was determined by standard curved line for tyrosine while concentration for each amino acid was determined by as well method by standard curved line for glycine (Trajković et al. 1983; Džamić, 1989).

RESULTS AND DISCUSSION

Analysis of free amino acids in barley and wheat showed that among the most present amino acids are: proline, threonine, glutamic acid, valine and tryptophan (Table 1). Proline was identified at the four barley cultivars (Novosadski 183, Novosadski 293, Novosadski 299, and Novosadski 307) and five wheat (KG-3526/98, KG-35171/94, KG-12, KG-3, and KG-3608/2/00).

Tryptophan is identified in one barley cultivar (Novosadski-307) and all six analyzed wheat lines (KG-3526/98, KG-35171/94, KG-12, KG-3, KG-3608/2/00, Partizanka), which is very important for synthesis of indolil acetic acid. Threonin was registered in two barley cultivars Novosadski 295 and Novosadski 307 and four wheat (KG-35171/94, KG-12, KG-3, Partizanka).

Threonine is very important for nutrition which is one of limiting essential amino acids. Threonine identified in two barley (Novosadski 295, Novosadski 307) and four wheat cultivars (KG-35171/94, KG-12, KG-3, and Partizanka). Dioxyphenilalanine was found at one samples KG-3526/98, while nor-leucine registered in one barley Novosadski 293.

Lysine is the first limiting essential amino acid for man. Among cereals, rice, oats and barley contain more lysine than other cereals. Accordingly, if all cereals were effectively and fully utilized for human consumption they would more use products which supply man's needs for essential amino acids. Glutamine, proline and glycine are principal amino acids in all cereal protein fractions. Differences in amino acid composition from wheat cannot explain the poorer baking performance of cereals such as rye and barely.

Protein fraction from different cereals exhibit similarities in the proportions of the amino acids glutamine, proline, glycine, and cysteine (Wiesner *et al*. 1980). However, sulfhydril-disulfide interchanges are the major reactions responsible for the formation of wheat dough and for development of a viscoelastic gluten (MacRitchie 1992).

Table 1

Variability of amino acid composition in chromatogram of 6 barley and 6 wheat cultivars

Cultivar	Barley						Wheat					
Amino acids	NS 183	NS 329	NS293	NS295	NS299	NS307	KG-3526/98	KG-5171/94	KG-12	KG-3	KG-3608/00	Partizanka
Sarcozin				+								
Proline	+		+		+	+	+	+	+	+	+	
Oxyproline		+										+
Glycine												
Threonine				+		+		+	+	+		+
Glutamic acid	+	+	+		+	+	+				+	
Valine		+		+	+		+	+	+	+	+	+
Norvaline	+	+	+					+	+	+	+	
Dioxyphenilalanine							+					
Methionine				+								
Tryptophan						+	+	+	+	+	+	+
Nor-leucine			+									
Phenylalanine												
Cistin-clorhidr.		+			+							
Arginin-clorhid						+						
α-aminokapron		+										

Amino acid contents of analyzed cereal cultivars

The highest total concentration of free amino acid (92 mg/ml) was found at the wheat line KG-35171/94 while the lowest (35 mg/ml) at the wheat cultivar Partizanka. The highest total concentration in barley was found at the cultivars Novosadski 293 (81 mg/ml), Novosadski 307 (41 mg/ml). Percent of total concentration of the free amino acid in wheat was

in ratio from 7.00% (Partizanka) to 18.40% (KG-35171/94, while for barley varied between 8.2% (Novosadski 307) and 16.1% (Novosadski 293) Table 2.

Glutamic acid is very important for nitrogen metabolism in cell. Products of degradation of glutamic acid are used for biosynthesis of sugar (sucrose). In gliadine storage proteins glutamic acid present as glutamine and have important source of nitrogen for germ nutrition.

Table 2

Total concentration of free amino-acids in grain of wheat and barley cultivars

Barley Cultivar	Concentration (mg/ml)	%	Wheat cultivar	Concentration (mg/ml)	%
Novosadski 183	50	10.0	KG-3526/98	75	15.0
Novosadski 329	68	13.6	KG-35171/94	92	18.4
Novosadski 293	81	16.1	KG-12	75	15.0
Novosadski 295	43	8.5	KG-3	82	16.4
Novosadski 299	72	14.4	KG-3608-2/00	61	12.2
Novosadski 307	41	8.2	Partizanka	35	7.00

The highest concentration of glutamic acid was in two wheat KG-3526/98 and KG-3608-2/00 (6.5 mg/ml). (Table 3) Similar concentration of glutamic acid was in wheat (Djukic, 2004; Djukic *et al.* 2006) which were found the ratio from 4.25 to 8.75 mg/ml.

Concentration of proline varied from 2 mg/ml (KG-35171/94) to 12.5 mg/ml (Novosadski 329). The high proline content has an effect on the secondary structure of gliadine polypeptides because the formation of alpha helices is hindered by proline side chains.

Table 3

Concentration of some amino acids

Amino acid	Cultivar	Concentration (mg/ml)	Amino acid	Cultivar	Conc. (mg/ml)
Glutamic acid	KG-3526/98	6.5	**Proline**	Novosadski 329	12.5
	KG-3608-2/00	6.5		KG-35171/94	2.0
Threonine	KG-35171/94	1.0		KG-3608-2/00	4,25
Norvaline	KG-35171/94	2.0			

Threonine was in the highest concentration in wheat KG-35171/94 (1.0 mg/ml), while at the norvaline was the highest in the same wheat 2 mg/ml (Table 3).

There are large differences in the amino acid composition of cytoplasmic and storage proteins (Table 2). Storage proteins of wheat characterized the high proportion of glutamic acid

and praline and low proportion of lysine, methionine and tryptophan. In some omega gliadine glutamic acid content is over the 50%, while contents of S-containing amino acids are low. Among the essential amino acid content in wheat grain determined also, cysteine (2.2 mg/ml), tyrosine (3.7 mg/ml), arginine (4.7 mg/ml) and histidine (2.0 mg/ml) (Laszitity 1995). The low level of lysine, arginine and histidine and low level of free carboxyl groups places among the least charged proteins. In contrary of storage proteins, metabolically active proteins contain considerably less glutamic acid and proline and have higher proportions of lysine and arginine which give these proteins a higher nutritive value, but lower functional (bread making) properties.

Barley, sorghum, rye and oat proteins have lower digestibilities (77-88%) than those of rice, maize and wheat (95-100%). The biological value and net protein utilization of cereal proteins is relatively low due to deficiencies in essential amino acids and low protein availability (Chaven and Kadam 1989).

CONCLUSION

The analyzed barley and wheat cultivars showed differences according to amino acid composition as well amino acid concentration. Proline and glutamic acid had the highest concentration in analyzed barley and wheat. The highest concentration of threonine and norvaline was identified in wheat. The differences of amino acid composition of proteins have important influence to nutritive value, which depends from proportion of amino acid in seeds. The amino acids are under genetic control and changes of amino-acid composition is possible realize through changes of composition of protein fraction and its proportion during breeding process. For improving nutritional value are necessary select barley and wheat lines in terms of lysine content and higher protein content.

LITERATURE

[1] CHAVEN, J. K., KADAM, S. S. Nutritional improvement of cereals by fermentation. CRC Critical Reviews in Food Science and Technology **28**(5): 349. 1989.

[2] GRUJIĆ-INJAC, B. Chemistry of amino acid and proteins. Sci. book. Belgrade.1962

[3] ĐUKIĆ, N. Biochemical analysis of prolamins in wheat *Triticum durum*. Ph.D. thesis. University of Belgrade, 116. 2004.

[4] ĐUKIĆ, N., MATIĆ, G., KONJEVIĆ, R. Biochemical analysis of gliadins of wheat *Triticum durum*. *Kragujevac J. Sci*., **27**, 131-138. 2005.

[5] ĐUKIĆ, N., KNEŽEVIĆ, D., CVIJANOVIĆ, D., JELOČNIK, M., IVANOVIĆ, L. Aminoacids contents in barley and wheat. Economics of Agicul. TB 53, 21-28. 2006.

[6] DŽAMIĆ, M. (1989) Protocols in Biochemistry. Sci. book. Belgrade.

[7] ELIASSON, A. C., LARSSON, K. Cereals in Breadmaking. New York, Marcel Dekker, Inc., pp. 376 1993.

[8] KASARDA, D. D., AUTRAN, J.C., LEW, E.J.L., NIMMO, C.C., SHEWRY, P.R. N-terminal amino acid of ω-gliadins and ω-secalins: implications for the evolution of prolamin genes. Biochim. Biophys, Acta, 747, 138-150. 1983.

[9] LÁSZITITY, R., LÁSZTITY, LJ. Phytic acid in cereal technology. In: Advanced in cereal science and technology. Vol. 10. (Pomeranz, Y. Ed.) American association of cereal chemists. St. Paul, MN. pp.309. 1990.

[10] LÁSZTITY, R. The Chemistry of Cereal Proteins. Second Ed, CRC Press. 1995.

[11] MACRITCHIE, F. Physicochemical properties of wheat proteins in relation to functionality. Adv. Protein Chem. **36**, 2-11. 1992.

[12] SIMMONDS, D.H. Wheat proteins: their chemistry and nutritional. potential 'Wheat Science - Today and Tomorrow', eds, L.T. Evans & W.J. Peacock, p.149-157. Cambridge. Univ. Press. 1981.
[13] TRAJKOVIĆ, J., MIRIĆ, M., BARAS, J., ŠILER, S. Anaysis of food products. University of Belgrade, 1983.
[14] WIESNER, H., SEILMEIER, W., BELITZ, H.D. Vergleichende Untersuchungen uber partielle Aminosauresequenzen von Prolaminen und Glutelinen verschriedener. Getreidearten. Z. Lebensm. Unters. Forsch. 170, 17. 1980.