

## ON THE NECESSITY TO STANDARDIZE WHEAT BRAN FOR ANIMAL FEEDING

## O POTREBI STANDARDIZIRANJA PŠENIČNIH POSIJA ZA HRANIDBU ŽIVOTINJA

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### SUMMARY

A series of studies was performed, testing the chemical composition and nutritional value of 105 samples of wheat bran taken from mills and pasta manufacturers in the years 2006-2007. The basic nutrients were determined, namely dry mass, crude ash, crude protein, crude fat, crude fiber, fiber fractions, starch and sugar, and metabolic energy were evaluated. The analysis of the study results concerning the basic nutrients found in wheat bran, and particularly crude fiber, fiber fractions (NDF, ADF and ADL), starch and sugar revealed a high differentiation in the obtained data. A detailed analysis of the data, as well as a visual assessment of the samples, resulted in distinguishing three types of products: standard wheat bran, white wheat bran and hard (durum) wheat bran. The results of the studies suggested that standard wheat bran was characterized by a chemical composition which was similar to the values presented in the tables quoting the feeds' chemical composition and nutritional value. White wheat bran revealed nearly twice lower values of crude fiber content (ca. 40g/kg) and fiber fractions: NDF (190 g/kg), ADF (55 g/kg), ADL (12 g/kg), while it contained more than a double amount of starch – ca. 420 g/kg, compared to ca. 200 g/kg in standard bran. The results of analyzing the share of the above mentioned nutrients in fine durum bran reached intermediate values. It turned out that metabolic energy was differentiated, with its value close to the data presented in the table in case of standard bran and higher by 2-3 MJ/kg in white bran. Within "white" and "standard" wheat bran types, lower coefficients of variation were obtained, as a rule, e.g. the coefficient of variation for crude fiber dropped from 22% to 13%, while the coefficient of variation for starch went down from 34% to 20%

Key words: wheat bran, basic nutrients, amino acids, standardization

### INTRODUCTION

By-products of cereal processing for animal feed purposes are characterized by significant differences. The chemical composition and nutritional value

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of wheat bran is influenced primarily by the degree of grinding wheat into flour. Therefore, standardization becomes of extraordinary importance. In the tables developed by Smulikowska and Rutkowski (2005) wheat bran is divided into two classes: one of low (63 g/kg) and the other of high (95 g/kg) fiber content, with a low differentiation of the other nutrients. In the tables developed by Novus six types of wheat bran are quoted (Raw Material Compendium, 1996). Feeding standards for cattle, sheep and goat (1997) include the data on the chemical composition of three types of wheat bran. The component which affects most significantly the nutritional value of wheat bran is crude fiber. That is why Council Directive 1996/25/EC on the circulation of feed materials (3) makes it obligatory to declare the raw fiber content in wheat bran available on the market, Regulation of MARD (2007a).

Advances in plant growing, introducing new varieties, changing environment, different degrees of fertilization and new processing technologies make it necessary to constantly update the information on the by-products coming from milling industry and related to feed products. The aim of the present study was to assess the chemical composition and nutritional value of wheat bran produced in Polish mills, as well as to carry out their standardization.

## MATERIAL AND METHODS

The material for the study was provided by a total of 105 samples of wheat bran collected from domestic production plants. Wheat bran samples were collected by authorized samplers, in compliance with the regulations. The samples were collected from possible all regions, taking into account varied technologies and degree of grinding.

Basal nutrient analyses, starch, sugar, fiber fractions, and metabolically energy evaluation on the basis of regression equations were made for all collected samples. The basal nutrients content: total protein, crude fat, crude fiber, moisture, and ash were determined by official methods using automatic analyzers in the case of protein, fat, and fiber (Regulation of MARD, 2007). Starch was analyzed using polarimetric method and sugar concentration by Luff-Schoorl's titrimetric method (Regulation of

MARD, 2007). Fiber fractions were assayed according to Ankom methods (Operator's Manual, 1997). Metabolizable energy ME of wheat bran for poultry was calculated with the use of the regression equation for wheat products according to European Table of Energy Values (1989). EM for pig was calculated according to Hoffmann and Schiemann's equation with Müller and Kirchgessner's modifications given in Pig Feeding Standards (1993).

$$\text{ME}_N (\text{kJ/kg}) = \text{dm} (\text{g/kg}) \times 16.78 - \text{ash} (\text{g/kg}) \times 16.78 - \text{c fib} (\text{g/kg}) \times 69.2 \quad [1]$$

Amino acids (without tryptophan) were determined by ion-exchange chromatography in automatic amino acid analyzer AAA 400 Ingos (Commission Directive 98/64/EC, 1998). Tryptophan was assayed by high performance liquid chromatography method (Commission Directive 2000/45/EC, 2000).

The results of the research were statistically analyzed and compared with the data available in specialist journals and tables. The obtained results made the basis to assess the possibility of wheat bran standardization, taking into account grinding technologies.

## RESULTS AND DISCUSSION

The results of testing basic nutrients in wheat bran, particularly crude fiber, fiber fractions (NDF, ADF and ADL), starch and sugar, varied significantly. A detailed analysis of the data concerning grinding technologies and the obtained results, as well as visual evaluation of the samples, led to identifying three types of wheat bran: standard wheat coarse bran, wheat white bran and hard wheat durum bran. The results of the study presented in Table 1 indicated that standard wheat coarse bran was characterized by its chemical composition similar to that quoted in nutritional recommendations (Smulikowska and Rutkowski, 2005) and in Nutritional Norms for Pigs (1993). Wheat white bran contained twice lower amounts of crude fiber (ca. 40 g/kg) and fiber fractions: NDF (190 g/kg), ADF (55 g/kg), ADL (12 g/kg) and more than a double amount of starch (420 g/kg) in comparison with standard soft wheat coarse bran (200 g/kg). The the examined nutrients content in standard wheat coarse bran

reached intermediate values. Metabolizable energy turned out to be varied, similar to the tabular data in case of standard wheat bran and higher by 2-3 MJ/kg in case of wheat white bran. Within the same types of "coarse" and "white" wheat bran, coefficients of variation for the results were generally lower, e.g. in case of crude fiber coefficient of variation for the results went down from 22% to 13%, and in case of starch from 34% to 20%.

The results of the study were in conformity with German (GLG) and French (INRA) data concerning the nutrients content in wheat bran (Table 2). It should be noted that the tables presenting the chemical composition and nutritional value of feedstuffs, quoted in Raw Material Compendium (2), distinguish the following types of wheat bran: soft wheat coarse bran, soft wheat white bran, soft

wheat red shorts, soft wheat fine bran, hard wheat bran, hard wheat shorts. The results of the studies on wheat bran suggested that there is a need for its standardization through distinguishing three groups of bran (standard wheat bran, white wheat bran and hard wheat bran, differing in chemical composition and nutritional value. Within individual groups of bran, 67% ( $\pm$ SD) of the results related to the nutritional elements content, especially total protein, fat and ash, were within tolerance limits defined in the regulation of MARD (2007b), despite the fact that the samples had been collected in different places of the country. The results concerning the crude fiber and starch content (Table 1 and 2) revealed an inversely proportional correspondence, which reflected adequately the effect of the grinding process on those parameters.

**Table 1. Basic nutrients content and energetic value of tested wheat bran (n=105)**

**Tablica 1. Sadržaj osnovnih hranjivih tvari i energetska vrijednost testiranih pšeničnih posija (n=105)**

Nutrient, g/kg Hranjiva tvar g/kg	Wheat bran together (n=105) Mean $\pm$ SD (CV) Pšenične posije zajedno	Soft wheat coarse bran (n=80) Mean $\pm$ SD (CV) Grube posije od mekane pšenice	Soft wheat white bran (n=20) Mean $\pm$ SD (CV) Bijele posije od mekane pšenice	Hard wheat bran (n=5) Mean $\pm$ SD (CV) Posije od tvrde pšenice
Dry matter - Suha tvar	874 $\pm$ 9.4 (1.1)	874 $\pm$ 9.0 (1.0)	871 $\pm$ 7,2 (0.8)	865 $\pm$ 2.8 (0.3)
Crude protein* - Sirove bjelančevine*	144 $\pm$ 11.0 (7,6)	142 $\pm$ 9.5 (6,7)	149 $\pm$ 3.0 (2.0)	180 $\pm$ 10.6 (5.9)
Crude fat - Sirova mast	31.7 $\pm$ 5.6 (17.6)	29.1 $\pm$ 5.9 (20.3)	28.8 $\pm$ 3.3 (11.5)	44.0 $\pm$ 1.6 (3.6)
Ash - Pepeo	48.2 $\pm$ 6.6 (13,7)	49.5 $\pm$ 5.1 (10.3)	38.2 $\pm$ 10.4 (27.2)	38.7 $\pm$ 3.2 (8.3)
Crude fiber - Sirova vlaknina	84.7 $\pm$ 17.5(20.7)	89.3 $\pm$ 12.2 (13.7)	43.0 $\pm$ 16.1 (37.4)	72.6 $\pm$ 5.2 (7.2)
NDF	375 $\pm$ 69.1 (18.4)	394 $\pm$ 45.9 (11.6)	194 $\pm$ 65.7 (33.9)	281 $\pm$ 3.2 (1.1)
ADF	113 $\pm$ 21.9 (19.4)	118 $\pm$ 13.6 (11.5)	54.8 $\pm$ 20.9 (38.1)	79.7 $\pm$ 6.4 (8.0)
ADL	30.2 $\pm$ 11.9 (39.4)	31.6 $\pm$ 9.2 (29.1)	12.6 $\pm$ 6.1 (48.4)	16.0 $\pm$ 6.9 (43.1)
Starch - Škrob	216 $\pm$ 72.2 (44.4)	196 $\pm$ 47.1 (24.0)	414 $\pm$ 75.2 (18.2)	153 $\pm$ 133 (86.9)
Sugars as sucrose - Šećeri kao sukroza	50.6 $\pm$ 6.2 (12.2)	52.1 $\pm$ 4.8 (9.2)	36.2 $\pm$ 0.3 (0.8)	44.1 $\pm$ 0.3 (0.7)
EM - poultry - EM - perad, MJ/kg	7.99 $\pm$ 1.31(16.4)	7.64 $\pm$ 0.93(12.2)	11.0 $\pm$ 1.1 (10.0)	8.84 $\pm$ 0.37 (3.9)
EM - pig - EM - svinje, MJ/kg	8.9 $\pm$ 0.76(8.5)	8.7 $\pm$ 0.51(5.9)	10.5 $\pm$ 0.57(5.4)	9.35 $\pm$ 0.1 (1.1)

SD – standard deviation, g/kg; CV – coefficient of variation, %; \* (N x 5,7)

**Table 2. Basic nutrient content in wheat bran according to German and French data****Tablica 2. Sadržaj osnovnih hranjivih tvari u pšeničnim posijama prema njemačkim (DLG) i francuskim podacima (INRA)**

Nutrient Hranjiva tvar g/kg	Source of data Izvor podataka	Soft wheat coarse bran Grube posije od mekane pšenice	Soft wheat white bran (shorts) Bijele posije od mekane pšenice	Hard wheat bran Posije od tvrde pšenice
Dry matter Suha tvar	DLG INRA	880 870	nd 870	877 880
Crude protein* Sirove bjelančevine*	DLG INRA	143 147	nd 155	135 156
Crude fat Sirova mast	DLG INRA	37 40	nd 38	nd 47
Ash - Pepeo	DLG INRA	58 58	Nd 28	nd 44
Crude fiber Sirova vlaknina	DLG INRA	108 106	nd 41	nd 100
NDF	DLG INRA	nd 461	nd 180	nd 369
ADF	DLG INRA	nd 139	nd 50	nd 121
ADL	DLG INRA	nd 31	nd 20	nd 33.3
Starch Škrob	DLG INRA	145 165	nd 336	nd 194
Sugars as sucrose Šećeri kao sukroza	DLG INRA	56,3 47	nd 50	nd 65
EM - poultry EM - perad, MJ/kg	DLG INRA	6.21 6.02	nd 2720 (11.38)	nd 1400 (5.86)
EM - pig, MJ/kg EM - svinje, MJ/kg	DLG INRA	8.33 9.25	nd 12.47	nd 10.06

\* (crude protein = nitrogen x 5,7); DLG, INRA – German (DLG) and French (INRA) data, according to Raw Material Compendium (1996); nd – not determined

The results of testing the amino acids content in wheat bran (Table 3), irrespective of the type of bran, were only slightly varied and similar to the tabular data (Smulikowska and Rutkowski, 2005; Raw Material Compendium). The amino acids content was characterized by insignificant differences,

amounting to ca. 10%. This provides a basis in search for a correlation between the protein content and the level of amino acids, by using available regression equations (Smulikowska and Rutkowski, 2005; Relandeau and Eudaimon, 2008).

**Table 3. Amino acid content of wheat bran, g/kg (n=20)****Tablica 3. Sadržaj aminokiselina u pšeničnim posijama, g/kg (n=20)**

Amino acids Aminokiseline, g/kg	Wheat bran - Pšenične posije			DLG	INRA	Dane Drob*
	min-max	average prosječno, X	SD (CV)			
Dry matter - Suha tvar	854 - 880	870	11.9 (1.4)	880	870	880
Asparagine	8.6 - 12.9	10.0	1,29 (12.9)	10.9	nd	nd
Threonine	3.7 - 5.5	4.5	0,29 (6.4)	5.5	5.4	4.5
Serine	5.1 - 7.0	6.3	0,82 (13.0)	6.6	nd	nd
Glutamine	23.9 - 35.5	27.3	3,47 (12,7)	26.0	nd	nd
Proline	7.8 - 12.0	9.6	1,13 (11.8)	8.7	nd	nd
Glycine	6.1 - 8.4	7.4	0,78 (10.5)	8.6	nd	nd
Alanine	5.5- 7.7	6.6	0,72 (10.9)	8.0	nd	nd
Valine	5.9 - 7.5	6.7	0,60 (8.9)	7.3	7.2	6.7
Isoleucine	3.8 - 5.5	4.5	0,50 (11.1)	5.1	5.2	5.0
Leucine	7.6 - 11.1	8.9	1,13 (12.7)	9.1	9.5	8.7
Thyrosine	3.3 - 5.5	4.1	0,58 (14.1)	4.2	nd	nd
Phenylalanine	4.9 - 6.7	5.8	0,60 (10.3)	5.3	nd	nd
Histidine	3.6 - 4.4	3.8	0,27 (7.1)	3.6	3.9	3.4
Lysine	4.8 - 6.6	5.4	0,66 (12.2)	6.2	5.5	5.7
Arginine	8.5 - 11.2	9.7	0,98 (10.1)	8.3	10.5	9.4
Cysteine	2.7 - 3.8	3.1	0,37 (11.9)	2.8	3.0	2.8
Methionine	2.0 - 3.0	2.4	0,30 (12.5)	2.2	2.0	2.1
Tryptophan	1.9 - 2.8	2.2	0,28 (12.7)	2.5	2.4	2.3

SD – standard deviation, g/kg; CV – coefficient of variation, %

\* Nutritional Norms for Poultry, 2005 – dry mass content 88%; nd – not determined

### CONCLUSIONS

The chemical analyses performed in the present study made it possible to evaluate the composition and the nutritional value of wheat bran available on the domestic market, and to compare the obtained results with the data quoted in feed chemical composition tables and specialist literature. The

results of studying wheat bran suggest that it needs to be standardized through distinguishing three groups (standard wheat coarse bran, wheat white bran and hard wheat bran) which clearly differ in their chemical content and nutritional value. The amino acid composition of bran protein was similar to the tabular data.

In conclusion, standardization of wheat bran should be considered as necessary and purposeful, depending on processing technologies (the samples of white wheat bran shorts and hard wheat fine bran came from companies producing pasta). It is necessary to continue monitoring studies in order to confirm the composition of wheat bran depending on the technology used in processing wheat grain.

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## SAŽETAK

Proveden je niz testiranja kemijskog sastava i hranidbene vrijednosti 105 uzoraka pšeničnih posija iz mlinova i od proizvođača tjestenine u 2006. i 2007. godini. Određene su osnovne hranjive tvari, tj. procijenjeni su suha tvar, pepeo, sirove bjelančevine, sirova mast, sirova vlaknina, škrob i šećer, te metabolička energija. Analiza rezultata ispitivanja osnovnih hranjivih tvari u pšeničnim posijama, osobito sirove vlaknine, frakcije vlakana (NDF, ADF i ADL), škroba i šećera pokazala je velike razlike u dobivenim podacima. Detaljna analiza podataka kao i vizualna procjena uzoraka dala je tri različita tipa proizvoda: standardne pšenične posije, bijele pšenične posije i tvrde

(durum) pšenične posije. Rezultati istraživanja navode na zaključak da standardne pšenične posije obilježava kemijski sastav sličan vrijednostima na tablicama koje prikazuju kemijski sastav i hranidbenu vrijednost krmiva (pšenice). Bijele pšenične posije pokazale su gotovo dvaput niže vrijednosti sadržaja sirove vlaknine (oko 40 g/kg) i frakcija vlakna: NDF (190 g/kg), ADF (55 g/kg), ADL (12 g/kg), dok je sadržaj škroba iznosio dvostruko više - oko 420 g/kg u usporedbi s oko 200g/kg u standardnim posijama. Rezultati analize udjela gore spomenutih hranjivih tvari u finim durum posijama dali su srednje vrijednosti. Pokazalo se da se metabolička energija razlikovala sa svojom vrijednošću blizu podacima na tablici za standardne posije i 2-3 MJ/kg višim od bijelih posija. U "bijelim" i "standardnim" tipovima pšeničnih posija dobiveni su, u pravilu, niži koeficijenti varijacije, npr. koeficijent varijacije za sirovu vlakninu pao je od 22% na 13%, dok se koeficijent varijacije za škrob snizio od 34% na 20%.

Ključne riječi: pšenične posije, osnovne hranjive tvari, aminokiseline, standardizacija

*narudžbenica*

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