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CHANGES IN AMINO ACID COMPOSITION IN THE PRODUCT (KERNEL) AFTER DEHULLING LUPIN SEEDS

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INTRODUCTION

Both the spectrum and the content of individual amino acids (AA) significantly affect the nutritional value of feed components. The actual content of individual AA in the feed significantly affects not only the production performance of animals but also their health status (Jeřábek et al., 2018). Since dietary protein sources are usually a costly part of feed for monogastric animals, farmers are currently trying to find affordable, often only natural protein resources of plant origin that can be effectively used for animal production.

The aim of the present study was to evaluate the effect of dehulling of the seeds from three white lupin varieties on the content of individual AA in the target products.

MATERIALS AND METHODS

The white lupin varieties Dieta, Amiga and Zulika were the object of the study. All the white lupin varieties were grown on the farm of the University of Veterinary and Pharmaceutical Sciences Brno in the land registry of Bartošovice village in the district Nový Jičín, under the identical soil and climate conditions (region where cereals are grown, 276 m above sea level, annual rainfall of 776 mm). Each variety was grown on the area of 10 ha. The sowing occurred at the beginning of April 2017 in the amount of 200 kg/ha. The crop was harvested at the end of August 2017. On a day before the harvest, 10 samples were taken from each variety (0.5 kg) from various parts of the field stand. In a laboratory, seeds were manually dehulled to produce a kernel. Hulls were the secondary product of this process.

The amino acid spectrum of the whole seed, kernel and hulls was determined by acid hydrolysis samples by 6 N HCl at 110 ° C for 24 hours using an automated AAA 400 amino acid analyzer (INGOS a.s., Prague). The analysis was based on the coloring reaction of amino acids with an oxidizing agent-ninhydrin. The following amino acids were determined from the amino acid spectrum: aspartic acid (Asp), threonine (Thre), serine (Ser), glutamic acid (Glu), proline (Pro), glycine (Gly), alanine (Ala), valine (Val), methionine (Met), isoleucine (Ile), leucine (Leu), tyrosine (Tyr), phenylalanine (Phe), histidine (His), lysine (Lys) and arginine (Arg).

The results were evaluated by mathematical and statistical methods using the software UNISTAT for Excel version 56, applying Tukey´s HSD multiple comparison test. Differences between mean values were tested at significance level $P < 0.05$. In the tables and figures, average values (on dry matter basis) found within the respective groups are presented.

RESULTS

It resulted from the amino acid analysis in the lupin seeds that the kernel after manual dehulling had the higher content of all analysed AA ($P < 0.05$), except for methionine (Met), for which no significant change was observed (Table 1, 2 and 3).

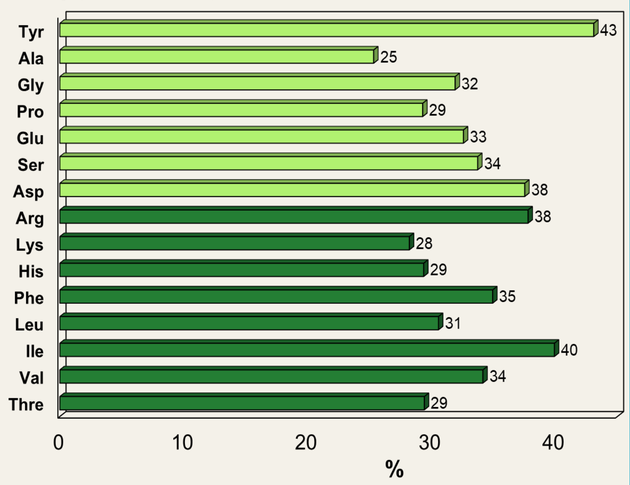
There were differences in the average values of individual AA as well as among the studied varieties. Higher differences in AA contents were shown among the individual varieties, the highest for Dieta (Figure 1), from 25.3% (Ala) to 43.1% (Tyr), lower for Amiga (Figure 2), from 14.3% (Val) to 24.3% (Arg) and the lowest for Zulika (Figure 3), from 11.1% (Val) to 17.7% (Tyr). The results showed that the highest effect on the increase of AA content after dehulling was observed in the kernel of Dieta. The percent increase of the total AA content in the kernel of the studied varieties, as compared to their whole seeds, was from 11.1% (Zulika) to 43% (Dieta). In comparison with the standard extracted soybean meal, the lupin kernel contained less Lys and Met, on the other hand, it contained markedly higher content of Arg, an essential AA especially for poultry.

Table 1: Content of amino acids in the whole seed, kernel and hull of Dieta lupin variety (g/kg of DM)

Amino acid	Whole seed x̄ ± sd	Kernel x̄ ± sd	Hull x̄ ± sd
Threonine	12.2 ± 0.71	15.8 ± 0.52	2.3 ± 0.59
Valine	13.6 ± 0.69	18.3 ± 0.97	3.3 ± 0.45
Methionine	1.1 ± 0.69	1.1 ± 0.41	0.2 ± 0.09
Isoleucine	14.1 ± 0.84	19.7 ± 0.70	2.6 ± 0.44
Leucine	25.8 ± 1.25	33.7 ± 1.03	4.3 ± 0.81
Phenylalanine	12.5 ± 0.70	16.9 ± 0.65	2.4 ± 0.54
Histidine	8.1 ± 0.50	10.5 ± 0.42	1.6 ± 0.27
Lysine	18.2 ± 1.09	23.3 ± 0.77	4.6 ± 0.63
Arginine	39.2 ± 1.92	54.0 ± 2.15	4.5 ± 1.22
∑ esencial AA	144.8	193.2	25.8
Asparagine	33.9 ± 3.38	46.6 ± 1.32	5.9 ± 1.17
Serine	17.3 ± 1.19	23.1 ± 0.69	3.2 ± 0.66
Glutamine	65.6 ± 3.15	87.0 ± 2.39	7.4 ± 1.87
Proline	17.5 ± 0.99	22.6 ± 0.73	4.6 ± 1.15
Glycine	13.3 ± 0.50	17.5 ± 0.70	2.7 ± 0.48
Alanine	10.8 ± 0.59	13.5 ± 1.00	2.3 ± 0.43
Tyrosine	14.8 ± 0.84	21.2 ± 0.83	2.0 ± 0.46
∑ non-esencial AA	173.1	231.4	28.2
Total of all AA	**317.9**	**424.6**	**54.0**

DM = dry matter; AA = amino acids; x̄ = mean; sd = standard deviation; ∑ = sum.

Figure 1: Significant increase in the content of individual amino acids (AA) in the kernel compared to the whole seed of Dieta lupin variety (in % of DM basis)



Essential AA are displayed using **dark blocks**.

Thre: threonine, Val: valine, Ile: isoleucine, Leu: leucine, Phe: phenylalanine, His: histidine, Lys: lysine, Arg: arginine, Asp: aspartic acid, Ser: serine, Glu: glutamic acid, Pro: proline, Gly: glycine, Ala: alanine, Tyr: tyrosine.

The results showed that the highest amount of total AA, as well as all essential AA, was present in the kernel, slightly lower amount was found in the whole seed and the lowest amount in the hull, for all the studied varieties. The results showed that the majority of AA is contained in the kernel and after dehulling, their content increased significantly as compared to the whole seed.

Regarding individual varieties, the highest content of all AA in the kernel dry matter was observed for Zulika 427 g/kg, slightly lower amount for Dieta 425 g/kg and markedly lower content for Amiga 387 g/kg. In the whole seed, the highest amount of all AA was observed for Zulika 374 g/kg, lower for Amiga 325 g/kg and the lowest for Dieta 318 g/kg; this finding is not in agreement with results of our earlier study (Zapletal *et al*., 2015). In that study, the highest content of all AA in the whole seeds was found in Dieta (365 g/kg), lower in Zulika (361 g/kg) and the lowest in Amiga (351 g/kg), while all the varieties were grown on the same farm as in the present study.

Differences in the total AA content among the observed varieties from different years thus show the substantial influence of the cultivation year itself.

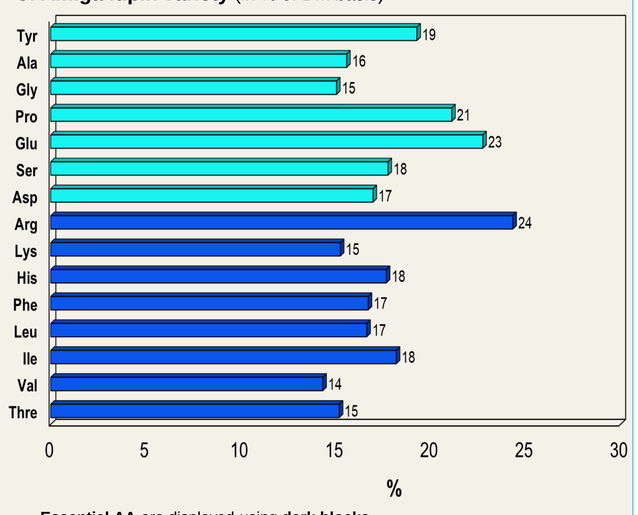
As for the hull, the highest content of all AA was observed for Zulika 62.3 g/kg, lower for Amiga 58.9 g/kg and the lowest for Dieta 54.0 g/kg.

Table 2: Content of amino acids in the whole seed, kernel and hull of Amiga lupin variety (g/kg of DM)

Amino acid	Whole seed x̄ ± sd	Kernel x̄ ± sd	Hull x̄ ± sd
Threonine	12.4 ± 0.52	14.3 ± 1.28	2.5 ± 0.64
Valine	14.3 ± 0.54	16.4 ± 0.80	3.6 ± 0.48
Methionine	0.9 ± 0.63	1.8 ± 0.81	0.2 ± 0.10
Isoleucine	15.1 ± 0.53	17.8 ± 0.96	2.9 ± 0.48
Leucine	26.3 ± 1.00	30.6 ± 1.57	4.7 ± 0.87
Phenylalanine	13.2 ± 0.64	15.4 ± 0.90	2.6 ± 0.58
Histidine	8.3 ± 0.54	9.8 ± 0.74	1.8 ± 0.29
Lysine	19.1 ± 0.67	22.0 ± 1.32	5.1 ± 0.68
Arginine	39.4 ± 1.74	49.0 ± 3.06	4.9 ± 1.32
∑ esencial AA	148.9	177.0	28.1
Asparagine	35.7 ± 1.52	41.7 ± 2.59	6.5 ± 1.27
Serine	17.4 ± 0.74	20.5 ± 1.59	3.5 ± 0.71
Glutamine	63.5 ± 2.60	78.0 ± 3.73	8.1 ± 2.02
Proline	18.9 ± 1.88	22.8 ± 4.90	5.0 ± 1.25
Glycine	13.7 ± 0.51	15.8 ± 0.82	3.0 ± 0.51
Alanine	11.4 ± 0.39	13.1 ± 0.39	2.5 ± 0.46
Tyrosine	15.3 ± 0.56	18.3 ± 1.54	2.2 ± 0.50
∑ non-esencial AA	175.8	210.1	30.8
Total of all AA	**324.6**	**387.1**	**58.9**

DM = dry matter; AA = amino acids; x̄ = mean; sd = standard deviation; ∑ = sum.

Figure 2: Significant increase in the content of individual amino acids (AA) in the kernel compared to the whole seed of Amiga lupin variety (in % of DM basis)



Essential AA are displayed using **dark blocks**.

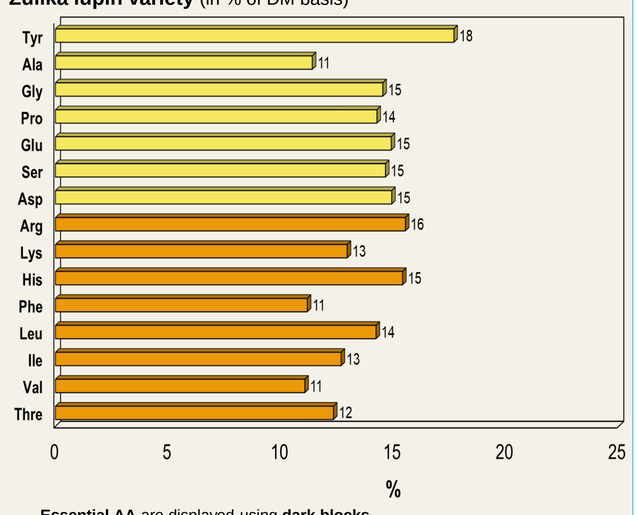
Thre: threonine, Val: valine, Ile: isoleucine, Leu: leucine, Phe: phenylalanine, His: histidine, Lys: lysine, Arg: arginine, Asp: aspartic acid, Ser: serine, Glu: glutamic acid, Pro: proline, Gly: glycine, Ala: alanine, Tyr: tyrosine.

Table 3: Content of amino acids in the whole seed, kernel and hull of Zulika lupin variety (g/kg of DM)

Amino acid	Whole seed x̄ ± sd	Kernel x̄ ± sd	Hull x̄ ± sd
Threonine	13.7 ± 0.48	15.4 ± 1.47	2.7 ± 0.33
Valine	16.1 ± 0.43	17.8 ± 1.56	3.7 ± 0.36
Methionine	1.5 ± 0.45	0.9 ± 0.61	0.2 ± 0.09
Isoleucine	17.4 ± 0.84	19.7 ± 1.60	3.0 ± 0.33
Leucine	29.4 ± 0.87	33.5 ± 2.80	5.0 ± 0.63
Phenylalanine	15.1 ± 0.61	16.8 ± 1.62	2.8 ± 0.37
Histidine	9.0 ± 0.35	10.3 ± 1.01	1.8 ± 0.22
Lysine	20.9 ± 0.61	23.6 ± 2.08	5.2 ± 0.51
Arginine	48.7 ± 2.30	56.2 ± 5.36	5.6 ± 1.50
∑ esencial AA	171.7	194.4	30.0
Asparagine	40.6 ± 1.45	46.7 ± 3.91	6.8 ± 0.82
Serine	19.8 ± 1.46	22.7 ± 1.98	3.8 ± 0.40
Glutamine	76.8 ± 1.74	88.3 ± 7.46	9.0 ± 1.38
Proline	20.1 ± 1.47	22.9 ± 1.25	4.7 ± 0.57
Glycine	15.2 ± 0.51	17.4 ± 1.57	3.0 ± 0.32
Alanine	12.5 ± 0.40	13.9 ± 1.20	2.6 ± 0.29
Tyrosine	17.7 ± 0.59	20.8 ± 1.77	2.4 ± 0.33
∑ non-esencial AA	202.7	232.7	32.3
Total of all AA	**374.4**	**427.1**	**62.3**

DM = dry matter; AA = amino acids; x̄ = mean; sd = standard deviation; ∑ = sum.

Figure 3: Significant increase in the content of individual amino acids (AA) in the kernel compared to the whole seed of Zulika lupin variety (in % of DM basis)



Essential AA are displayed using **dark blocks**.

Thre: threonine, Val: valine, Ile: isoleucine, Leu: leucine, Phe: phenylalanine, His: histidine, Lys: lysine, Arg: arginine, Asp: aspartic acid, Ser: serine, Glu: glutamic acid, Pro: proline, Gly: glycine, Ala: alanine, Tyr: tyrosine.

CONCLUSIONS

The results show that lupin seeds are a significant source of amino acids which makes them an important source of high-quality protein for animal nutrition. By dehulling, a kernel can be obtained which is nutritionally superior to seed and in which the content of essential and non-essential AA is increased. Based on the AA analysis of three white lupin varieties (Dieta, Amiga and Zulika) we have concluded that lupin seeds and their products contain only a very small amount of amino acid methionine. Except methionine, histidine was the least represented AA in the lupin protein; on the other hand, the highest content of arginine was found for all varieties which is the most typical and dominant AA although there are differences between the respective varieties.

In the tested varieties, the content of all essential AA in the kernel after dehulling increased from 13.2% (Zulika) to 33.0% (Dieta) and the content of all non-essential AA increased from 14.6% (Zulika) to 33.3 % (Dieta).

The content of all essential and non-essential AA was significantly reduced in the hull as compared to the whole seed from the evaluated lupin varieties, on average by 80%.

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