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

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INTRODUCTION

In addition to high protein content, white lupin (WL) seeds are also a valuable source of high-quality oil, which can not only increase the nutritional quality of animal products when feeding it to farm animals, but it may also exhibit some therapeutic effects (Straková et al., 2010; Chiofalo et al., 2012). In addition, Volek et al. (2018) found that the dehulling of WL seeds may increase the content of some beneficial fatty acids (FA). Inclusion of dehulled WL seeds into rabbit diet in the mentioned study led to a favorable effect on the content of some FAs in rabbit meat.

The objective of this study was to evaluate the effect of dehulling white lupin seeds on the nutritional value of fats in Diet, Zulika and Amiga varieties, comparing the contents of both individual fatty acids and FA groups in target products of these 3 varieties.

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.

In the extracted fat from seed, kernel and hull, the individual fatty acids were determined. The fat was extracted from the sample using a solvent mixture of n-hexane and isopropanol (ratio 6: 4). The solvent was evaporated on a vacuum evaporator. Subsequently, transesterification with BF_3 was carried out, converting fatty acids to volatile esters. Fatty acid esters were detected by Gas Chromatograph GC-2010 (SHIMADZU) gas chromatograph using a flame ionization detector and evaluated in the Gc Postrum program.

The following fatty acid were determined during the analysis: caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0), lauric acid (C12:0), tridecylic acid (C13:0), myristic acid (C14:0), palmitic acid (C16:0), margaric acid (C17:0), stearic acid (C18:0), arachidic acid (C20:0), tricosylic acid (C23:0), lignoceric acid (C24:0); *cis*-10-pentadecenoic acid (C15:1), palmitoleic acid (C16:1), *cis*-10-heptadecenoic acid (C17:1), oleic acid (C18:1*n*9), *cis*-11-eicosenoic acid (C20:1*n*9), erucic acid (C22:1*n*9), nervonic acid (C24:1*n*9); lenoleic acid (C18:2*n*6), *γ*-linolenic acid (C18:3*n*6), *α*-linolenic acid (C18:3*n*3), *cis*-11,14-eicosadienoic acid (C20:2*n*6), *cis*-8,11,14-eicosatrienoic acid (C20:3*n*6), arachidonic acid (C20:4*n*6), *cis*-11,14,17-eicosatrienoic (20:3*n*3), *cis*-5,8,11,14,17-eicosapentaenoic acid (20:5*n*3), *cis*-13,16-docosadienoic acid (C22:2*n*6), *cis*-4,7,10,13,16,19-docosahexaenoic acid (C22:6*n*3), *cis*-7,10,13,16-docosatetraenoic acid (C22:4*n*6).

The results were evaluated by statistical methods using the software UNISTAT for Excel version 56, applying Tukey´s HSD multiple comparison test. The contents of specific FAs ae given in g/kg of sample dry matter in *Tables 1* to *3* and *Figure 2*.

RESULTS

Regarding saturated fatty acids (SFA), their content (g/kg) increased in the kernel as compared to the whole seed for Dieta from 8.3 to 9.9, for Amiga from 8.4 to 9.7 and for Zulika from 4.4 to 8.9. Of the SFA group, palmitic acid (C16:0) was most represented in the lupin oil of all the analyzed varieties, in all the monitored parts of the seed (*Table 1, 2* and *3*). Its contents in the whole seed and kernel were significantly lowest in the Zulika variety and the highest in the Amiga variety; its content in the hull of the evaluated varieties then showed a completely opposite trend. The second most represented FA of SFA in the whole seed in all the varieties we evaluated was stearic acid (C18:0), which is not in agreement with the findings of Chiofalo et al. (2012), who found the second most represented behenic acid (C22:0) in the WL varieties of Luxor and Rosetta, but which was not found in the varieties we evaluated. The share of SFA from the total amount of FA in whole seed oil ranged from 13.8% (Amiga) to 14.7% (Zulika), and this proportion was almost the same in their kernels (*Figure 1*). A slightly lower proportion of SFA from total FA in dehulled WL seeds of Zulika variety (10%) was found by Volek et al. (2018).

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

Fatty acid	Whole seed x̄ ± sd	Kernel x̄ ± sd	Hull x̄ ± sd
C6:0	0.009 ± 0.003	0.011 ± 0.004	0.002 ± 0.0003
C8:0	0.000 ± 0.000	0.000 ± 0.000	0.002 ± 0.001
C10:0	0.000 ± 0.000	0.000 ± 0.000	0.001 ± 0.001
C12:0	0.009 ± 0.003	0.010 ± 0.004	0.006 ± 0.001
C13:0	0.010 ± 0.001	0.011 ± 0.004	0.004 ± 0.007
C14:0	0.075 ± 0.013	0.087 ± 0.008	0.017 ± 0.007
C16:0	6.110 ± 0.796	7.104 ± 0.575	0.596 ± 0.164
C17:0	0.068 ± 0.008	0.083 ± 0.003	0.030 ± 0.042
C18:0	0.783 ± 0.110	0.891 ± 0.075	0.099 ± 0.040
C20:0	0.680 ± 0.096	0.787 ± 0.067	0.083 ± 0.025
C23:0	0.128 ± 0.018	0.143 ± 0.054	0.025 ± 0.007
C24:0	0.433 ± 0.074	0.482 ± 0.093	0.063 ± 0.021
C14:1	0.000 ± 0.000	0.002 ± 0.007	0.0002 ± 0.001
C15:1	0.009 ± 0.003	0.008 ± 0.006	0.006 ± 0.014
C16:1	0.431 ± 0.052	0.509 ± 0.048	0.028 ± 0.011
C17:1	0.056 ± 0.010	0.066 ± 0.009	0.004 ± 0.001
C18:1n9	18.110 ± 2.604	20.763 ± 1.672	1.136 ± 0.340
C20:1n9	4.374 ± 0.688	5.293 ± 0.443	0.182 ± 0.063
C22:1n9	1.544 ± 0.242	1.947 ± 0.179	0.064 ± 0.023
C18:2n6	13.245 ± 1.947	14.801 ± 1.151	1.687 ± 0.480
C18:3n3	7.589 ± 1.221	9.057 ± 0.819	0.928 ± 0.257
C20:2n6	0.272 ± 0.048	0.317 ± 0.028	0.015 ± 0.006
C20:3n6	0.090 ± 0.011	0.117 ± 0.019	0.010 ± 0.003
C20:4n6	0.008 ± 0.004	0.006 ± 0.006	0.000 ± 0.000
C20:3n3	0.074 ± 0.029	0.082 ± 0.031	0.007 ± 0.012
C20:5n3	2.372 ± 0.370	2.928 ± 0.316	0.156 ± 0.045
C22:2n6	0.242 ± 0.183	0.117 ± 0.053	0.003 ± 0.002
C22:6n3	0.057 ± 0.010	0.065 ± 0.025	0.003 ± 0.001
C22:4n6	0.034 ± 0.014	0.041 ± 0.009	0.000 ± 0.000

DM = dry matter; x̄ = mean; sd = standard deviation.

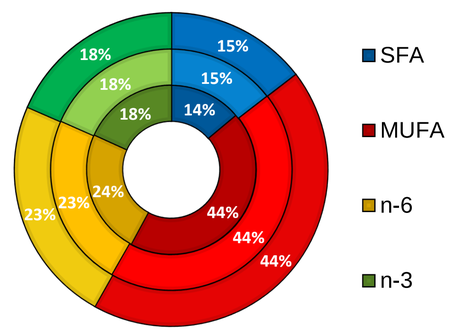
Table 2: Content of fatty acids in whole seed, kernel and hull of **Zulika** lupin variety (g/kg of DM)

Fatty acid	Whole seed x̄ ± sd	Kernel x̄ ± sd	Hull x̄ ± sd
C6:0	0.008 ± 0.003	0.010 ± 0.005	0.002 ± 0.0001
C8:0	0.000 ± 0.000	0.000 ± 0.000	0.002 ± 0.001
C10:0	0.000 ± 0.000	0.000 ± 0.000	0.0004 ± 0.001
C12:0	0.008 ± 0.004	0.010 ± 0.001	0.000 ± 0.001
C13:0	0.009 ± 0.0004	0.010 ± 0.001	0.002 ± 0.0001
C14:0	0.044 ± 0.005	0.080 ± 0.010	0.020 ± 0.004
C16:0	3.202 ± 0.397	6.607 ± 0.901	0.671 ± 0.137
C17:0	0.049 ± 0.005	0.073 ± 0.005	0.018 ± 0.003
C18:0	0.372 ± 0.062	0.742 ± 0.161	0.115 ± 0.028
C20:0	0.333 ± 0.051	0.684 ± 0.126	0.089 ± 0.018
C23:0	0.085 ± 0.019	0.158 ± 0.018	0.031 ± 0.005
C24:0	0.261 ± 0.031	0.533 ± 0.073	0.085 ± 0.017
C14:1	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
C15:1	0.008 ± 0.003	0.010 ± 0.001	0.001 ± 0.001
C16:1	0.254 ± 0.026	0.544 ± 0.051	0.037 ± 0.009
C17:1	0.028 ± 0.004	0.000 ± 0.0001	0.004 ± 0.002
C18:1n9	8.888 ± 1.172	18.712 ± 2.721	1.188 ± 0.285
C20:1n9	2.412 ± 0.269	5.191 ± 0.596	0.174 ± 0.064
C22:1n9	1.014 ± 0.149	2.220 ± 0.299	0.067 ± 0.028
C18:2n6	6.872 ± 0.824	13.625 ± 1.518	2.027 ± 0.399
C18:3n3	4.078 ± 0.429	8.364 ± 0.824	1.117 ± 0.221
C20:2n6	0.194 ± 0.152	0.203 ± 0.184	0.050 ± 0.035
C20:3n6	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
C20:4n6	0.003 ± 0.004	0.011 ± 0.005	0.0004 ± 0.001
C20:3n3	0.043 ± 0.008	0.087 ± 0.012	0.004 ± 0.002
C20:5n3	1.269 ± 0.168	2.690 ± 0.408	0.194 ± 0.054
C22:2n6	0.194 ± 0.152	0.203 ± 0.184	0.050 ± 0.035
C22:6n3	0.038 ± 0.009	0.093 ± 0.019	0.005 ± 0.002
C22:4n6	0.024 ± 0.013	0.042 ± 0.071	0.001 ± 0.002

DM = dry matter; x̄ = mean; sd = standard deviation.

As for monounsaturated fatty acids (MUFA), their content (g/kg) in the kernel increased as compared to the whole seed for Dieta from 24.5 to 28.6, for Amiga from 26.4 to 30.8 and for Zulika from 12.6 to 26.7. Concerning MUFAs, oleic acid (C18:1n9) was the most represented in the lupin oil of the varieties we analyzed, in all monitored parts of the seed - whole seed, kernel and hull. The second most represented FA in this group was erucic acid (C22:1n9). These findings are broadly consistent with the results of Chiofalo et al. (2012). The proportion of MUFA of total FA in whole seed oil in our study ranged from 42.4% (Zulika) to 43.4% (Amiga). Somewhat higher MUFA levels for whole seeds of WL (50.9-53.5%) were found by Chiofalo et al. (2012) and their significantly higher proportion in dehulled Zulika variety (65.5%) was found by Volek et al. (2018).

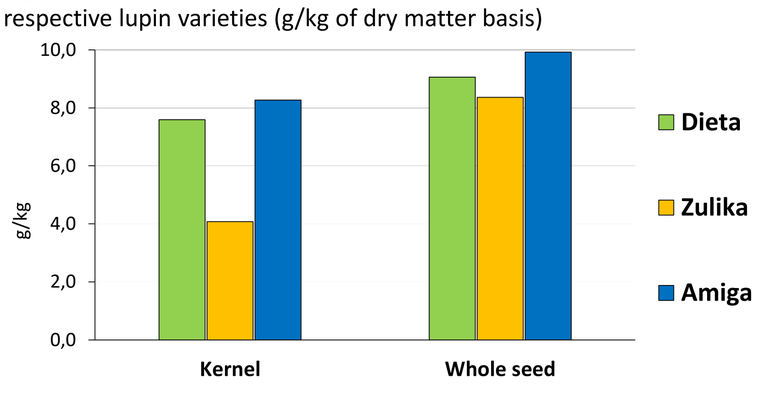
Figure 1: Representation of individual fatty acid groups (%) of their total count in the kernel of the evaluated white lupin varieties



Inner ring is for **Amiga**
Middle ring is for **Zulika**
Outer ring is for **Dieta**

Concerning polyunsaturated fatty acids (PUFA) from the group *n*-6 PUFA, their content (g/kg) in the kernel increased as compared to the whole seed for Dieta from 13.9 to 15.4, for Amiga from 15.1 to 16.8 and for Zulika from 7.3 to 14.1. Of the n-6 PUFAs, linoleic acid (C18:2n6) was most represented in the lupin oil of the varieties analyzed, its content among the evaluated varieties showing the same trend as the total n-6 PUFA content. The proportion of n-6 PUFAs from total FA in whole seed oil ranged from 24.5% (Dieta) to 24.9% (Amiga).

Figure 2: Content of *α*-linolenic acid in the whole seed and kernel in the respective lupin varieties (g/kg of dry matter basis)



Regarding the group *n*-3 PUFAs, their content (g/kg) in the kernel increased as compared to the whole seed for Dieta from 10.1 to 12.1, for Amiga from 10.9 to 12.7 and for Zulika from 5.4 to 11.2. Of n-3 PUFAs, *α*-linolenic acid (C18:3n3) was most represented in the lupin oil of the varieties evaluated. Dehulling whole seeds of the studied varieties led to the highest increase in the C18: 3n3 content of the Zulika kernel (*Figure 2*). The proportion of n-3 PUFAs from total FA in whole seed oil ranged from 17.8% (Diet) to 18.3% (Zulika).

CONCLUSIONS

From the point of view of diet, the quality of lupin fat is positive for its high content of unsaturated FA and a favourable proportion of individual groups of FA.

Based on our results it can be stated that after dehulling of lupin seeds, the contents of all groups of FA (SFA, MUFA, n - 6 PUFA, n - 3 PUFA) have increased absolutely in the kernel. However, in the studied varieties, the proportion of individual FA groups to their total content differed only slightly between seed oil and kernel oil.

Although the total content (g/kg of DM) of the individual FA groups differed significantly ($P \leq 0.05$) among the evaluated varieties of WL, their percentages proportion were almost identical in the studied varieties.

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