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Research note

Chemical composition of dehulled seeds of selected lupin cultivars in comparison to pea and soya bean

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ABSTRACT

With the objective of promoting the cultivation, usage, and consumption of lupin, in the present study, the chemical and fibre composition of dehulled seeds of seven cultivars of different lupin species (*Lupinus angustifolius*, *Lupinus albus* and *Lupinus luteus*) was determined in comparison to pea (*Pisum sativum*) and soya bean (*Glycine max*).

The mean protein content of lupin was significantly higher compared to pea ($P < 0.001$) and similar to soya bean, whereas the proportion of calculated carbohydrates was lowest for lupin ($P < 0.001$). The content of total dietary fibre and of calculated soluble fibre was higher for lupin compared to pea ($P \leq 0.003$) and soya bean ($P \leq 0.013$). In contrast to the existing literature, the soluble fibre content of lupin contributed about 75% of the total dietary fibre.

In conclusion, dehulled lupin seeds can be considered as a valuable source of plant protein and dietary fibre, while simultaneously being low in carbohydrates. Therefore, lupin should be exploited more efficiently within human and also animal nutrition. In further studies, the impact of dehulling lupin seeds and of using different methodologies in fibre analyses on the results of chemical composition should be elucidated.

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1. Introduction

In recent years, numerous human intervention studies have demonstrated that both protein and dietary fibre of sweet lupin exert several physiological benefits (Bähr, Fechner, Kiehntopf, & Jahreis, 2014; Bähr, Fechner, Krämer, Kiehntopf, & Jahreis, 2013; Duranti & Morazzoni, 2011; Fechner, Fenske, & Jahreis, 2013; Fechner, Kiehntopf, & Jahreis, 2014; Fechner, Schweiggert, Hasenkopf, & Jahreis, 2011; Johnson, Chua, Hall, & Baxter, 2006). Despite various physiological, ecological and technofunctional advantages of lupin, to date, the use of this legume in human nutrition is low (Hall, Thomas, & Johnson, 2005).

Moreover, there are only few reports on the chemical composition of dehulled seeds of lupin. However, for use in human nutrition, lupin seeds are generally dehulled. The thick seed hull, which accounts for ca. 25% of lupin seed on a wet weight basis (Evans, Cheung, & Cheetham, 1993) was found to differ considerably from the lupin kernel in crude protein, fat and crude fibre (Hove, 1974; Pisarikova, Zraly, Bunka, & Trckova, 2008) as well as in dietary fibre composition (Guillon & Champ, 2002; Pisarikova & Zraly, 2010).

Therefore, the present study aimed to provide data concerning the chemical composition of dehulled seeds of three lupin species (*Lupinus angustifolius*, *Lupinus albus* and *Lupinus luteus*) and to compare these with that of dehulled pea (*Pisum sativum*) and dehulled soya bean (*Glycine max*).

2. Material and methods

2.1. Processing of legume seeds

Legume seeds of seven cultivars of sweet lupin (*L. angustifolius*, *L. albus* and *L. luteus*), three cultivars of pea (*P. sativum*), and three cultivars of soya bean (*G. max*) were processed to kernel preparations by the Fraunhofer Institute for Process Engineering and Packaging (Freising, Germany). Therefore, the cleaned seeds were

Abbreviations: DM, dry matter; FM, fresh matter; TDF, total dietary fibre; SDF, soluble dietary fibre; IDF, insoluble dietary fibre.

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Table 1
Compositional data of the dehulled legume seeds.

Species	Cultivar	DM	Ash	Protein	Fat	Carbohydrates[d]
		$n = 2$	$n = 2$	$n = 2$	$n = 1$	$n = 1$
		[g/100 g FM]	[g/100 g DM]	[g/100 g DM]	[g/100 g DM]	[g/100 g DM]
Lupinus angustifolius	Probor[e]	90.6 ± 0.3	3.84 ± 0.01	44.2 ± 0.4	7.2	8.0
	Borlu[e]	87.5 ± 0.1	4.17 ± 0.10	42.8 ± 0.3	6.8	6.1
	Boregine[e]	89.2 ± 0.1	3.72 ± 0.09	40.0 ± 1.0	8.3	8.8
	Vitabor[e]	90.9 ± 0.0	4.11 ± 0.05	38.8 ± 0.4	9.8	8.7
Lupinus albus	TypTop[f]	88.8 ± 0.2	4.46 ± 0.09	52.9 ± 0.1	1.4[a]	–
	Lublanc[g]	91.2 ± 0.1	5.01 ± 0.02	45.3 ± 0.5	12.7	4.5
Lupinus luteus	Bornal[e]	89.2 ± 0.1	5.09 ± 0.16	55.3 ± 0.8	8.2	10.4
Mean value ± SD		**89.6 ± 1.3**	**4.34 ± 0.54**b	**45.6 ± 6.2**a	**8.8 ± 2.2**[b]	**7.8 ± 2.1**
Pisum sativum	Attika[h]	91.4 ± 0.0	2.82 ± 0.06	23.2 ± 0.5	2.4	56.5
	Lido[i]	88.0 ± 0.2	3.15 ± 0.14	23.1 ± 0.1	3.5	61.1
	Santana[h]	88.0 ± 0.9	3.22 ± 0.03	25.2 ± 0.2	12.1	40.5
Mean value ± SD		**89.1 ± 2.0**	**3.06 ± 0.21**c	**23.8 ± 1.2**b	**6.0 ± 5.3**	**52.7 ± 10.8**
Glycine max	Marlin[h]	92.1 ± 0.1	7.04 ± 0.03	47.5 ± 1.8	6.5[a]	–
	Malandro[j]	91.2 ± 0.2	6.33 ± 0.04	47.8 ± 0.8	3.3[a]	–
	Hefeng[j]	91.8 ± 0.1	6.48 ± 0.03	52.1 ± 0.3	3.1[a]	–
Mean value ± SD		**91.7 ± 0.4**	**6.62 ± 0.37**a	**49.2 ± 2.6**a	**4.3 ± 1.9**[c]	–

FM, fresh matter; DM, dry matter.
Means within the same column with different online letters (a,b,c) are significantly different ($P \leq 0.05$).
– Carbohydrates could not be calculated due to deoiling.
[a] Flaked seeds were deoiled using hexane.
[b] Means and SD of fat were calculated without the fat content for the deoiled cultivar of lupin.
[c] Mean and SD of the deoiled cultivars of soya bean.
[d] Carbohydrates were calculated as follows: 100 − (ash + protein + fat + total dietary fibre).
[e] supplied by Saatzucht Steinach GmbH & Co. KG (Steinach, Germany).
[f] supplied by Seeds Asociacón Chilena de Lupino A.G. (Temuco, Chile).
[g] supplied by Vermarktungsgesellschaft Bioland Naturprodukte mbH & Co. KG (Bad Kreuznach, Germany).
[h] supplied by Thüringer Zentrum Nachwachsende Rohstoffe der TLL (Dornburg-Camburg, Germany).
[i] supplied by Pflanzenzucht Oberlimpurg (Schwäbisch Hall, Germany).
[j] supplied by Purvegan GmbH (Ramsen, Germany).

dehulled using an underdrifter disc sheller (Streckel & Schrader KG, Hamburg, Germany). Hulls and kernels were separated using a zigzag air-classifier (Multiplex, Hosokawa Alpine AG, Augsburg, Germany). The kernels were flaked using a flaking mill with coolable rollers (Streckel & Schrader KG, Hamburg, Germany). Finally, the flakes were grinded to fine flour using an impact mill.

2.2. Chemical composition

The nutrient composition of the legume kernel preparations was analysed by standard methods of the Association of Official Analytical Chemists (AOAC, 1990). The contents of insoluble dietary fibre (IDF; estimated by neutral detergent fibre analysis) and total dietary fibre (TDF) were determined by standard procedures according to Van Soest, Robertson, and Lewis (1991) and AOAC 985.29 (enzyme set: BIOQUANT® TDF, Merck, Darmstadt, Germany; filter machinery: Fibertec™ E, FOSS Analytical, Hilleroed, Denmark), respectively. The content of carbohydrates was calculated as follows: carbohydrates = 100 − (ash + protein + fat + TDF). Soluble dietary fibre (SDF) content was determined by deducting IDF from TDF.

2.3. Statistical analyses

After testing for normal distribution, differences in chemical composition between lupin, pea, and soya bean were estimated applying *t*-test for independent samples, being statistically significant with $P \leq 0.05$ (SPSS 19.0, SPSS Inc., Chicago, USA).

3. Results and discussion

3.1. Chemical composition of lupin vs. pea and soya bean

The mean protein content of lupin was significantly higher compared to pea ($P < 0.001$) and similar to soya bean (Table 1). In comparison to other legumes used in human nutrition, lupin, together with soya bean, contain high proportions of protein (Kohajdova, Karovicova, & Schmidt, 2011). Moreover, lupin protein appears to positively impact cardiovascular risk factors, such as hypercholesterolaemia (Bähr et al., 2014, 2013; Naruszewicz, Nowicka, Klosiewicz-Latoszek, Arnoldi, & Sirtori, 2006; Sirtori et al., 2012; Weisse et al., 2010) and hypertension (Bähr et al., 2013; Naruszewicz et al., 2006). The mean content of minerals in lupin, reflected by the ash proportion, was found to be between that of pea ($P = 0.006$) and soya bean ($P < 0.001$). Besides having a low content of available carbohydrates *per se*, lupin flour positively affects postprandial glycaemic (Dove et al., 2011; Hall et al., 2005) and insulinaemic response (Hall et al., 2005) when added to meals rich in starch. The content of TDF as well as of calculated SDF was higher for lupin compared to pea ($P \leq 0.003$) and soya bean ($P \leq 0.013$; Table 2). Numerous studies have observed that consumption of legume kernel fibres might contribute to the prevention of colorectal cancer and improve colonic health in general (Fechner et al., 2013; Johnson et al., 2006; Schweizer et al., 1983).

3.2. Comparison with previous analyses

In the present study, the mean values of DM, ash, protein, fat, and calculated carbohydrates of lupin were largely comparable with the few data that is available on dehulled lupin seeds of *L. angustifolius* (Belski, 2012; Evans et al., 1993; Hove, 1974) and *L. albus* (Hove, 1974). The contents of TDF were comparable to that analysed in the kernels of three cultivars of *L. angustifolius* (Evans et al., 1993), whereas Pisarikova and Zraly (2010) detected higher proportions of TDF in dehulled seeds of *L. albus* (43 g/100 g DM).

In contrast to the existing literature (Belski, 2012; Evans et al., 1993; Guillon & Champ, 2002; Kohajdova et al., 2011; Pisarikova & Zraly, 2010), which reports small proportions of SDF for lupin, in the present study, the SDF contributed about 75% of the TDF. The

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