Variation in seed size, seed coat proportion and protein content in *L. angustifolius*

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Introduction

Lupin has a thick seed coat compared to other grain legumes, which increases the fiber content and reduces the digestibility. Improved nutritional value could be expected by lower seed coat proportion. The seed coat proportion in *L. angustifolius* is between 19% and 29%.
The perspectives for further reductions in the seed coat proportion can be perspectivated by the excamples of wild and domesticated peas. In wild pea a seed coat proportion up to 27 % is found while the proportion in domesticated pea is around 10%.

Objectives

- Identifying genotypes with a thin seedcoat
- Estimating genetic variation in seedcoat thickness
- Evaluating protein contents in nucleus and seed coat

Methods

Twenty-five genotypes of *Lupinus angustifolius* and two genotypes of *Lupinus opsianthus* a synonym of *L. angustifolius* varying in seed size were investigated in this experiment.
The analysed seeds were harvested at The Royal Veterinary and Agricultural University Copenhagen in 1999 and 2000, except seeds of Bordako and Borweta, which were received from Germany.
For eleven of the genotypes, samples from the two years were investigated separately.
Thirty seeds from each sample were analysed, except for two genotypes where less seeds were available.
Eight of the genotypes are registered varieties; Tanjil, Wonga, Bordako, Borweta, Danja, Illyarie, Mirtan and Kalya, nineteen are lines in breeding research in Denmark.

Seeds were imbibed over night, the seed coat cut with a scalpel, and carefully removed. Each nucleus and seed coat was placed in a glass flask, dried 24 hours at 70ºC, weighed, and seed coat proportion calculated.
A theoretical seed coat thickness is calculated under the assumptions of equal mass density of seed coat and nucleus and a spherical shaped seed. The seed coat thickness is calculated as the difference between the radius of the whole seed and the radius of the nucleus.

The coats and nucleus from each genotype in each year were grinded in a coffee mill, dried 24 hours at 70ºC. Then 14 mg of each nucleus, and 50 mg of seed coat material was taken for N analysis.
Nitrogen content vas determined by the Dumas method. Thereafter crude protein content was calculated by multiplying total N with 6.25 as known from the Kjeldahl method.

Results

The seed weight ranged from 52 mg to 226 mg. (table 1, figure 1).
In general seed coat proportion deceased with increasing seed size (figure 1) however, one small seeded genotype with low seed coat proportion was identified. (Genotype *L. Opsianthus*-1 (table 1, figure 1 and figure 2)).
Calculated seed coat thickness was from 0.18 mm to 0.30 with a weak tendency to be thicker in big seeded genotypes (table 1, figure 2).

Protein content ranged from 31% to 44% in whole seed, from 41% to 56% in nucleus and from 2.2% to 5.7% in seed coat (table 1).
Protein concentration in seed does not seem to follow nucleus weight, and both small and big seeded genotypes with high protein concentration were identified (table 1).

Figure 1. Seed coat plotted against whole seed weight for individuals of 25 genotypes *L. angustifolius* and 2 genotypes *L. opsianthus*

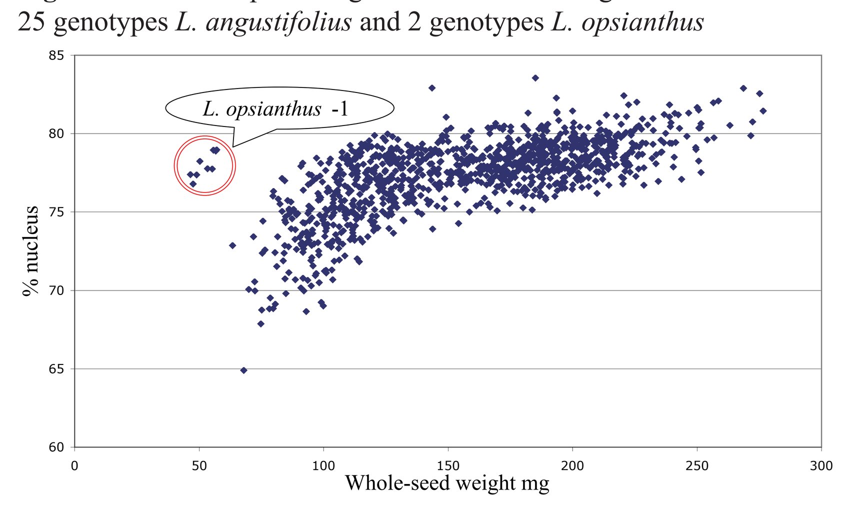

Figure 2. Calculated seed coat thickness (µm) in perspective with whole seed weight of 25 genotypes *L. angustifolius* and 2 genotypes *L. opsianthus*

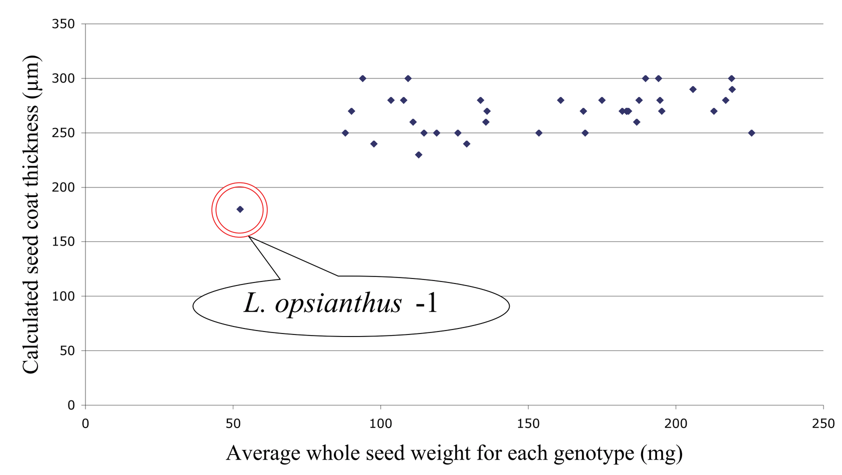

Table 1. Average seed weight, proportion of seed coat, theoretical seed coat thickness and crude protein contents in 25 genotypes of *Lupinus angustifolius* and 2 genotypes of *Lupinus opsianthus*

Genotypes	Harvest-year	Weight (whole seed) mg	Seed coat %	Theoretical Seed coat thickness mm	Crude protein Nucleus %	Crude protein Seed coat %	Crude protein Whole seed %
1	1999	219	22.2	0.30	53.8	5.7	44
1	2000	226	18.8	0.25	50.2	3.1	42
Illyarie	2000	219	21.5	0.29	47.3	2.8	37
Danja	2000	217	20.6	0.28	46.5	3.6	37
2	1999	195	21.6	0.28	46.1	2.9	38
2	2000	206	22.1	0.29	44.7	3.1	35
3	1999	182	20.9	0.27	44.8	2.8	35
3	2000	213	20.3	0.27	45.7	2.9	37
4	2000	194	23.2	0.30	49.3	3.7	39
Tanjil	2000	190	23.0	0.30	47.2	4.1	38
Kalya	2000	188	22.0	0.28	45.9	2.8	37
Wonga	2000	187	22.2	0.26	46.4	3.1	37
5	1999	175	22.3	0.28	46.4	2.8	37
5	2000	195	20.8	0.27	47.2	2.7	38
6	1999	183	21.1	0.27	47.5	2.6	38
6	2000	184	21.3	0.27	47.2	2.6	37
7	1999	183	21.1	0.27	46.0	2.4	37
8	2000	169	21.8	0.27	46.3	2.5	36
9	1999	134	23.8	0.28	45.7	2.3	35
9	2000	161	22.7	0.28	45.9	2.4	37
10	1999	111	23.7	0.26	49.3	3.1	38
10	2000	169	20.5	0.25	47.0	2.9	38
11	1999	119	22.4	0.25	47.8	3.0	38
11	2000	154	20.9	0.25	46.4	3.0	38
12	1999	136	22.5	0.26	43.2	2.5	35
Bordako	2000	136	22.9	0.27	41.2	2.4	31
13	2000	129	21.2	0.24	50.4	3.3	41
Borweta	2000	126	22.4	0.25	45.0	2.4	37
14	1999	113	21.5	0.23	49.5	2.8	40
15	1999	98	23.5	0.24	46.9	3.0	37
15	2000	115	22.5	0.25	50.3	3.1	40
Mirtan	2000	103	25.9	0.28	48.5	3.8	37
16	1999	94	28.5	0.30	55.7	5.0	38
16	2000	109	27.1	0.30	52.8	4.6	39
17	1999	90	26.6	0.27	44.6	2.4	34
17	2000	108	25.4	0.28	44.1	2.2	34
L.Opsianthus-2	2000	88	24.7	0.25	41.7	5.1	32
L.Opsianthus-1	1999	52	21.9	0.18	46.6	4.7	38
	Average	**154**	**22.6**	**0.27**	**47.1**	**3.2**	**37**

Conclusions

- The general picture of constant seed coat thickness and nucleus protein concentration at various seed sizes, and the identification of genotypes with small seed and thin seed coat could allow for breeding of new big seeded, thin-coated varieties with increased protein content.
- When looking at seed coat thickness in genotypes with different seed sizes, the calculated theoretical seedcoat is very useful to evaluate the seeds actual seedcoat thickness, without favoring the big seeded genotypes.
- If positive characteristics like the big seed of genotype 1, the protein content of genotype 16 and the thin seed coat of *L. opsianthus*-1 (table 1) could be combined in one, the theoretical seed produced would be a 225 mg seed with 14% seed coat, 54% crude protein in nucleus and 47% crude protein in whole seed.