VARIATION IN MAJOR AND MINOR ELEMENT COMPOSITION OF NEW ZEALAND GROWN LUPIN SEED

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ABSTRACT

Concentrations of the major and minor elements in the kernels and testas of New Zealand grown lupins from the species *L.albus*, *L.angustifolius*, *L.cosentinii* and *L.mutabilis* were determined.

INTRODUCTION

A knowledge of mineral compositions of whole seed and seed components is necessary for diet formulations from legume seed, especially if kernel and testas are separated by processing. The mineral composition of lupin seed has been reported[1-9] but much of this data is either incomplete, or varies widely because of differences in methods of separation and analysis[10]. Furthermore, the physical characteristics of the seed are often not reported[11]. Parameters such as seed moisture content and the proportion of kernel to testa can affect the concentration of elements in the seed. Environmental influences have a marked effect on elemental concentration in lupin seed[9].

Chemical analysis of seeds can give an indication of their nutritional value and can also be of use in chemotaxonomy, plant breeding and the selection and development of new food products.

MATERIALS AND METHODS

Dry matter and ash were determined using the methods of AOAC[12]. Following digestion in a nitric/perchloric acid mixture magnesium, sodium, potassium and calcium were determined by emission and absorption spectroscopy in the presence of added strontium. Phosphorus was determined using the phosphomolybdate method adapted for autoanalysis[13] and sulphur by the automated turbidimetric method[14]. Molybdenum was determined by a modification of the dithol method[15] and boron by the curcumin method[16]. Manganese, copper and zinc were determined by a semi-automated method[17].

RESULTS AND DISCUSSION

The relative proportions of kernel and testa in these lupins have been previously presented[18]. Ash concentration of the kernel was in all cases higher than the amount found in the testa (TABLE 1).

TABLE 1. Mean dry matter and ash content of each lupin (g/kg).

	L. albus	*L. angustifolius*	*L. cosentinii*	*L. mutabilis*	S.E.
Dry matter	942	934	956	943	2.12
Ash: Kernel	34	39	38	43	0.73
Testa	22	22	20	32	

Major Element Concentrations: The concentration of major elements in the kernel and testa are presented in TABLE 2. Sulphur, phosphorus, potassium and magnesium were more concentrated in the kernel. This contrasts with calcium which was more concentrated in the testa of all four species. These values are similar to those previously reported[8] except for higher reported concentrations in South African grown *L.mutabilis*[1] viz. 1.8 g/kg Ca; 4.3 g/kg Mg; 8.8 g/kg P; 16.3 g/kg K and 1.2 g/kg Na. The values (TABLE 2) were similar to New Zealand grown *L.mutabilis* L1011, *L.albus* cv. Ultra and *L.angustifolius* cv Unicrop[6]. The contrast between New Zealand and South African results may have been due to environmental factors or to the use of different lupin cultivars.

The total phosphorus of Egyptian *L.termis* (syn. *L.albus*) was similar to that reported here[19]. Gad *et al.*[19] noted that 27% of the total phosphorus of *L.termis* was bound to phytic acid and was therefore unavailable unless processed in some way. Sulphur concentrations were comparable to values obtained in Australia[8] except for slightly higher levels in *L.albus* cv. Ultra and *L.angustifolius*. Sodium concentration was low in all four species. Values were similar for *L.angustifolius* but lower than previous reported[4] values for *L.albus* and *L.mutabilis*.

Soil fertility can markedly affect elemental concentration in lupin seed. Phosphorous concentration rose in response to addition of phosphatic fertilizer[8] while the sulphur content of *L.angustifolius* seed rose when it was grown in culture solutions of increasing sulphur concentration[5]. The seed in this experiment was grown on medium to high fertility soils therefore mineral concentrations in the seed were not likely to have been limited by a low supply of nutrients.

TABLE 2. Mean major element concentrations (g/kg)

	S	P	K	Mg	Ca	Na
Kernel						
L.albus	2.3	4.0	10.1	1.4	1.1	0.2
L.angustifolius	3.7	5.1	10.9	2.1	1.1	0.5
L.cosentinii	4.7	6.4	13.5	1.9	0.4	0.5
L.mutabilis	3.6	6.4	12.1	2.5	0.2	0.2
Testa						
L.albus	*	0.6	5.6	0.6	5.8	0.4
L.angustifolius	*	0.3	4.4	0.7	5.0	0.5
L.cosentinii	*	0.2	5.7	1.1	4.7	0.5
L.mutabilis	0.7	0.5	5.2	2.4	5.9	0.2
S.E.	0.18	0.18	0.26	0.04	0.09	0.05

* not measurable

Trace Elements: The concentrations of trace elements in the kernel and testa of the four lupin species is shown in TABLE 3. The most notable feature was the very high manganese concentration in *L.albus* which is concentrated in the kernel. The total whole seed value is similar to the previously reported[6] value of 767 mg/kg for cv. Ultra also grown at Lincoln College. However, the same cultivars contained up to 2190 mg/kg when grown in West Germany, and 49 lines of *L.albus* in Western Australia had concentrations of 1060 to 4690 mg/kg[8]. Hill[4] reported concentrations as low as 164 mg/kg in this species. The mechanism for this manganese accumulation is not known but it may be due to the ability of this species to absorb previously unavailable manganese from the soil[8]. In contrast, a split seed disorder in *L.angustifolius* occurs when the seed contains less than 10 mg/kg manganese[7] The differences in seed manganese concentrations in the literature may be due to variation in soil manganese supply. Manganese values in *L.albus* and *L.mutabilis* are in general agreement with previously reported New Zealand values[4,6], though a higher value of 58 mg/kg has been reported in *L.angustifolius*[6]. Manganese levels exceeding 1,000 mg/kg have been reported to cause loss of appetite, mild toxicity and reduced growth rate in pigs. However high liveweight gains are possible up to 1,300 mg/kg[8].

TABLE 3. Mean trace element concentrations (mg/kg)

	Mn	Zn	Cu	B	Mo	Se (µg/kg)
Kernel						
L.albus	950	40	7	18	0.9	134
L.angustifolius	27	50	9	20	1.4	256
L.cosentinii	156	66	12	14	1.8	257
L.mutabilis	50	44	10	14	1.6	93
Testa						
L.albus	202	13	12	13	0.4	101
L.angustifolius	11	20	6	10	0.2	256
L.cosentinii	84	7	7	10	0.1	261
L.mutabilis	15	26	10	18	0.2	85
S.E.	23.02	3.02	0.69	1.04	0.06	1.95

Values for zinc are similar to those previously reported[4,6] except in *L.mutabilis* where between 54 and 59 mg/kg have been reported[1,11]

Copper appears to be evenly distributed throughout the seed although it has been suggested[4] that it is more concentrated in the kernel of *L.albus*. The data presented agrees with previously reported values[4,6,11].

Selenium levels in kernel and testa ranged from 93 to 261 µg/kg in these lupins. These values are low when compared to 310 µg/kg reported for *L.termis* (syn. *L.albus*)[20].

The levels of boron and molybdenum are similar to those reported by Hill[4].

CONCLUSIONS

Generally New Zealand grown lupin seed has a good balance of major and trace elements. The high manganese levels in the kernel of *L.albus* may be a cause for concern but can easily be allowed for in most ration formulations.

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