THE INFLUENCE OF DOMESTICATION AND ENVIRONMENT ON THE VALUE OF LUPINS (LUPINUS SPP.) AS A FEED FOR RUMINANTS

by

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SUMMARY

Lupins have significant potential in Australian agriculture due to their high protein concentration and their adaptation to a range of soil types. Lupins also can fix nitrogen and provide a disease ‘break’ in cereal rotations, which contribute to their value in cropping systems. The lupin seed (L. angustifolius) is widely used as a supplementary feed for ruminants during the summer-autumn period and are a useful protein supplement for pigs and poultry in Australia. However, L. angustifolius does not perform well on fine-textured and/or alkaline soils, which occur on over 9 million hectares in the cereal zones of SA and WA. To solve this problem, plant breeders have commenced a selection program to domesticate L. pilosus and L. atlanticus which are more suited to these types of soils. At this early stage of domestication of L. pilosus and L. atlanticus, L. angustifolius was used as a benchmark to determine changes in seed structure and chemical composition which may result from breeding and selection of these two lupins. On the other hand, L. pilosus and L. atlanticus could be like L. cosentinii which is essentially a wild type adapted to southern Australian soil conditions and a valuable feed for sheep in this area.

Domestication had significant influences on both the seed size and seed coat structure of lupins and no significant impact on seed yield. Recently released cultivars (1987 and 1988) of L. angustifolius had smaller seeds with a thicker seed coat than those released in 1971 (Chapter 3), but the yield of these cultivars was not significantly higher than that of the cultivars released in early years. L. atlanticus, L. cosentinii and L. pilosus had similar seed yields to L. angustifolius under similar growing conditions with a May sowing in 1995 at Turrettfield, South Australia (Chapter 4), but they had much bigger seeds than the domesticated lupin (L. angustifolius) (Chapter 3 and 7). Selection for softseeded seeds resulted in a reduction of seed coat thickness in L. angustifolius, but thick seed coats were positively related to seed size of wild lupins (Chapter 3). The change in seed size and seed coat structure could result in poor adaptation to the environment and sensitivity to diseases, and hence yield loss.
With large amounts of *L. angustifolius* being fed to animals in Australia, nutrient content is a crucial factor for its utilisation efficiency by animals. Domestication of *L. angustifolius* from 197! (Uniharvest) to 1988 (Ganguru, Warrah and Yorrel) had no significant influence on N, ADF, NDF and mineral content except for seed S content (Chapter 5). A reduction of seed S content of cultivars released in 1988 compared to that of the cultivar released in 1976 could affect animal production when it is integrated over the 1.13 million tonnes (estimated by Edwards in 1994) being used by the intensive livestock industry. On the other hand, there was considerable variation in nutrient content (N, fibre and minerals) between lupin species (Chapter 5 and 7). *L. cosentinii* had a higher N, seed coat fibre, Mn, P and S content than *L. angustifolius* which could contribute to it being an excellent feed for ruminants, and its higher Mn and P content can be also benefit plant growth and development, resulting in high seed yields.

Growing conditions also play an important role in the yield, yield components and chemical composition of lupins. June sowing at Turretfield in 1995 significantly decreased the numbers of seeds and pods per plant and reduced yield by 29% when compared to a May sowing. June sowing also decreased the kernel N content of lupins, but had no significant effects on ADF and NDF content. Seeds grown in 1994 were much smaller than those grown in 1993 (26.7 vs 46.6 g/100 seed), had low nitrogen production of per 100 seed weight (1.6 vs 2.1 g N/100 seed) and low levels of Fe, Mn, Cu, Zn, K, P and S (Chapter 6). Location had no significant influence on seed N content. However high levels of seed ADF, NDF and lower levels of seed Mn occurred in seeds grown at Yeedanne compared to seeds grown at Minnipa Research Centre (Chapter 6). The significant changes both in seed yield and nutrient content (eg N and mineral) under different growing conditions could cause a fluctuation in animal production, particularly when over 200,000 tonnes of *L. angustifolius* seeds and 200,000 to 350,000 tonnes of *L. cosentinii* seeds are grazed annually by sheep in WA.

The potential of wild lupins (*L. atlanticus* and *L. pilosus*) as supplementary feed for sheep was determined by *in sacco* and *in vivo* methods. The parameters included
degradability in the rumen, DMD in vivo and feeding value. The similar degradability in sacco, DMD and feeding value of wild lupins and domesticated lupins at 150 g/head/day levels of supplementation to sheep may indicate that the higher levels of anti-nutritional factors of wild lupins are unlikely to affect their utilisation efficiency at the levels of supplement commonly provided for ruminants. Thus selection of very low levels of alkaloids in varieties will probably be of low priority for ruminant production.

Overall, the changes that have occurred with L. angustifolias over the past 40 years of breeding and selection would appear to offer a useful model for how the domestication of L. pilosus and L. atlanticus may progress. If there are no significantly different agronomic problems, these species seem to offer the opportunity of initially providing feed for ruminants via either direct grazing or as a seed supplement over large areas of farmland in southern Australia. As breeding progresses towards reduced alkaloid concentration, the seed also has the potential for increasing monogastric production.