# Potential health benefits of the Australian Lupin Bean

The Australian Lupin Bean (*Lupinus angustifolius*) belongs to the legume family. A longitudinal study of older people from Japan, Sweden, Greece and Australia concluded legume intake "the most protective dietary factor for longevity" (Darmadi-Blackberry *et al*., 2004).

The Australian Lupin Bean has a unique nutrient profile amongst legumes and vastly different to cereals and other grains. There is increasing evidence pointing to multiple health aspects of including lupin in the diet.

The following review articles provide a summary of scientific clinical and laboratory research undertaken, mainly in Australia and Europe, on lupin effects on health biomarkers over the past 20 years.

- Arnoldi A *et al*. (2015). The health benefits of sweet lupin seed flours and isolated proteins. *J. Functional Foods*. 18: 550-63
- Kouris-Blazos A & Belski R (2016). Health benefits of legumes and pulses with a focus on Australian sweet lupins. *Asia Pacific J Clininical Nutrition* 25: 1-17.
- Johnson SK, Clements J, Villarino CBJ & Coorey, R. (2017). Chapter 9. Lupins: Their unique nutritional and health-promoting attributes. *In*: The Gluten-free Ancient Grains: Cereals, Pseudocereals and Legumes- Sustainable, Nutritious and Health-promoting Foods for the 21st Century, eds J. R. N. Taylor and J. M. Awika. Elsevier, Amsterdam.
- Bryant L, Rangan A & Grafenauer S (2022). Lupins and Health Outcomes: A Systematic Literature Review. *Nutrients*. 14: 327
- Fernández Castillo R *et al*. (2023). Therapeutic Applications and Effects of Lupinus angustifolius and Its Components: A Systematic Review and Meta-Analysis. Foods 12: 2749;

In addition to human dietary intervention studies (see Table below) there are many reports exploring the mechanisms underlying potential lupin health benefits from *in-vitro* cell studies and in animal models. Notable are the studies involving the lupin specific proteins gamma and beta conglutin and their hydrolysed peptides (Lemus-Conejo *et al*., 2022).

**Satiety and reduced energy intake**

Due to their macro-nutrient composition (very high protein and dietary fibre, low fat and negligible carbohydrate) lupin contributes a low glycemic load as part of a meal and can increase satiety and reduce energy intake. This may assist in a reduction of daily food intake and therefore help maintain healthy body weight. Lee *et al*. (2006) found that subjects consuming bread enriched with lupin kernel flour at the expense of wheat flour consumed at least 20% less kilojoules; noting that the hormone ghrelin, known to stimulate appetite, was reduced in the subjects eating lupin bread.

**Glucose homeostasis and anti-diabetic potential**

Where lupin inclusion in the diet reduces total carbohydrate intake, post prandial blood glucose and insulin spikes are reduced. A 12 month study by Belski *et al*., (2010) found that a lupin enriched diet significantly lowered fasting insulin concentrations (16% for the men on the trial and 21% for the women) and improved the HOMA scores.

There are also multiple reports for a direct effect of the lupin specific protein γ-conglutin and its hydrolysed peptides reducing blood glucose levels. Bertoglio *et al.* (2011) tested a lupin seed γ-conglutin-enriched preparation in a glucose overload trial with both murine models and adult healthy volunteers. The results with rats showed a dose-dependent significant decrease of blood glucose concentration. Moreover, three test-product doses equivalent to 630, 315, and 157.5mg γ-conglutin, orally administered 30min before the carbohydrate supply, showed a relevant hypoglycemic effect in human trials. Insulin concentrations were not significantly affected. The general hematic parameters did not change at all.

More recently, Tapadia *et al.* (2021) concluded that γ-conglutin does not have an insulintropic effect but is an insulin mimetic and modulates glucose metabolism via the enzyme DPP4. Notably, γ-conglutin-derived peptides are absorbed through intestinal cell walls, enabling their bioactive capacity.

Lima-Cabello *et al*. (2017) published an *in-vitro* study investigating the potential use of lupin β-conglutin protein isoforms as a diabetes treatment. It was found that of the five purified recombinant fractions of β-conglutin: rβ1-, rβ2-, rβ3-, rβ4-, and rβ6-conglutin, that rβ1, rβ3,& rβ6 could bind to insulin eliciting a threefold increase mRNA expression levels of Insulin Receptor Substrate-1 (IRS-1) while decreasing the expression of pro-inflammatory genes (iNOS and IL-1β).

A further study assessed the activity of lupin β-conglutin proteins to reverse induced insulin resistance in pancreatic cells. Using ex-vivo and in-vitro systems purified recombinant β-conglutin proteins: rβ1, rβ3, and rβ6 were evaluated for their capacity to improve the insulin resistant state. All three rβ1, rβ3, and rβ6 produced significant changes to important biomarkers nitric oxide, GLUT-4 and mRNA expression IRS-1. The proteins also increased phosphorylation levels of the insulin signalling pathway activator p-IRS-1, improved glucose uptake in insulin resistant (IR-C) culture cells and suppressed oxidative stress produced by insulin-induced resistance on PANC-1 control (C) cells (Lima-Cabello *et al*, 2018).

**Cholesterol lowering**

A pooled data analysis consisting of 302 subjects showed that a *Lupinus angustifolius* diet (whole kernel or kernel fibre) had a positive impact on LDL cholesterol levels. Research has reported that proteins present in lupin reduce the expression of genes related to cholesterol synthesis and is associated with increased low-density lipoprotein receptor activity (Fernández Castillo R et al., 2023).

**Blood pressure lowering**

Lupins are one of the highest natural sources of the amino acid arginine which has been implicated in beneficial effects on endothelial function (improved blood vessel performance).

Also, lupin fibre has also demonstrated beneficial effects on blood pressure. Pilvi et al (2006) found lupin inclusion in the diet had a protective effect by normalizing blood vessel function of rats challenged with a salt loaded diet. A 16-week intervention trial by Lee *et al*. (2006) investigated the effect of lupin kernel enriched bread on blood pressure. They observed a significant improvement of blood pressure in the subjects eating the lupin bread (40% of the wheat flour was substituted with lupin) compared with the group on white bread. Another 12-month study by Belski *et al.* (2010) also demonstrated a significant blood pressure drop on the lupin group compared with the control group.

**Bowel health**

Johnson *et al*. (2006) found that Australian Lupin Bean enriched foods reduce transit time, lower the pH of the large intestine and significantly increases production of short chain fatty acids, in particular butyrate. These effects are known to help prevent constipation and potentially reduce the risk of colon cancer, as well as assisting with improvements in glucose tolerance and the insulin response.

Fechner *et al.* (2013) compared the effect of four different isolated fibres (Australian Lupin Bean kernel fibre, European White lupin kernel fibre, soy kernel fibre and citrus fibre) on putative risk factors for colorectal cancer in a randomised, double blind crossover human intervention trial. 78 subjects were given 25g of fibre for 2 weeks. All fibres increased faecal output and faecal moisture. However, only Australian Lupin Bean kernel fibre was shown to improve colonic function and have beneficial effects on putative risk factors for colorectal cancer such as faecal mass, transit time, SCFA, faecal pH and secondary bile acid concentration.

Significantly higher levels of bifidobacteria and significantly lower levels of the clostridia were observed in male subjects that consumed a diet with Australian Lupin Bean kernel fibre compared with the control (Smith et al., 2006).

More research on the pre-biotic effects of a lupin diet, the influence on the gut microbiome and potential colon and additional health benefits is warranted.

**Future Directions**

Consumption of lupin and health outcomes is a relatively new area of investigation. More research is desirable to expand the evidence base. Studies with adequately sized populations of defined health status and clearly defined lupin protein and/or fibre fractions are required to determine the minimum dose required for beneficial health effects.

**Allergy**

Lupin, like other protein containing foods may trigger an allergic reaction in a small percentage of the population. Some, but not all people who are allergic to peanuts also react to lupin. The range of severity of reaction to lupin is similar to that seen with other food allergens (Australasian Society of Clinical Immunology and Allergy, (2015).

**References**


Australasian Society of Clinical Immunology and Allergy (2015). Lupin Allergy – Information for Health Professionals (2015). ASCIA HP Lupin allergy 2015344.54 KB

Darmadi-Blackberry I *et al.* (2004). Legumes: The most important dietary predictor of survival in older people of different ethnicities. Asia Pacific J. Clinical Nutrition 13: 217–220.

Fernández Castillo R *et al*. (2023). Therapeutic Applications and Effects of Lupinus angustifolius and Its Components: A Systematic Review and Meta-Analysis. Foods 12: 2749;

Lemus-Conejo A *et al*. (2022). GPETAFLR, a peptide from Lupinus angustifolius prevents inflammation in microglial cells and confers neuroprotection in brain. Nutr Neurosci 25: 472-484.

Lima-Cabello E, et al. (2017). Narrow leafed lupin (Lupinus angustifolius) β-conglutin proteins modulate the insulin signaling pathway as potential type 2 diabetes treatment and inflammatory-related disease amelioration. Mol. Nutr. Food Res. 61: doi: 10.1002/mnfr.201600819.

Lima-Cabello, E., et al. (2018). Narrow-leafed lupin (Lupinus angustifolius L.) seed β-conglutins reverse the induced insulin resistance in pancreatic cells. Food & function, 9: 5176-5188.

Smith SC et al (2006). Lupin kernel fiber consumption modifies fecal microbiota in healthy men as determined by rRNA gene fluorescent in situ hybridization. Eur J Nutr. 45: 335-41

Tapadia M, Johnson S, Utikar R, Newsholme P, Carlessi R (2021). Antidiabetic effects and mechanisms of action of γ-conglutin from lupin seeds. Journal of Functional Foods 87: 104786.

## Controlled clinical dietary intervention studies involving the Australian Lupin Bean

| HEALTH INDICATOR | LUPIN CONSTITUENT | REFERENCE |
|---|---|---|
| **Satiety / reduced energy intake** | Whole kernel flour | Lee, YP et al (2006). Lupin-enriched bread increases satiety and reduces energy intake acutely Am J Clin Nutr. 84: 975-980 |
| | Whole kernel flour | Hall, RS *et al.* (2005). Australian sweet lupin flour addition reduces the glycaemic index of a white bread breakfast without affecting palatability in healthy human volunteers. Asia Pacific J. Clinical Nutrition 14: 91–97 |
| | Kernel fibre | Archer, BJ et al. (2004). Effect of fat replacement by inulin or lupin-kernel fibre on sausage patty acceptability, post-meal perceptions of satiety and food intake in men. British Journal Nutrition 91: 591-599. |
| | Whole kernel | Keogh J et al. (2011). Food intake, postprandial glucose, insulin and subjective satiety responses to three different bread-based test meals. Appetite 57 (3): 707-710. |
| **Reduced blood glucose and insulin response** | Whole kernel | Hall, RS *et al.* (2005). Australian sweet lupin flour addition reduces the glycaemic index of a white bread breakfast without affecting palatability in healthy human volunteers. Asia Pacific J. Clinical Nutrition 14: 91–97 |
| | Whole kernel | Lee, YP *et al* (2006). Lupin-enriched bread increases satiety and reduces energy intake acutely Am J Clin Nutr. 84: 975-980 |
| | Whole kernel | Dove, ER *et al.* (2011). Lupin and soya reduce glycaemia acutely in type 2 diabetes British J Nutrition 106: 1045-1051. Dove, ER et al. (2011). Lupin and soya reduce glycaemia acutely in type 2 diabetes British J Nutrition 106: 1045-1051. |
| | | Schopen, K. *et al.* (2017). Short-term effects of lupin vs. whey supplementation on glucose and insulin responses to a standardized meal in a randomized cross-over trial. Front. Physiol. 8: 198. |
| | Whole kernel | Skalos S *et al.* (2020). Effect of lupin-enriched biscuits as substitute mid-meal snacks on post-prandial interstitial glucose excursions in post-surgical hospital patients with type 2 diabetes. Nutrients 12: 1239. |
| | Gamma conglutin | Bertoglio JC *et al.* Hypoglycemic effect of lupin seed γ-conglutin in experimental animals and healthy human subjects. Fitoterapia 82: 933-938. |
| **Reduced hypertension** | Whole kernel | Lee, YP et al (2006). Lupin-enriched bread increases satiety and reduces energy intake acutely. Am J Clin Nutr. 84: 975-980 |
| | Whole kernel | Belski, R et al. (2010). Effects of lupin-enriched foods on body composition and cardiovascular disease risk factors: a 12-month |

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| | | randomized controlled weight loss trial. International Journal of Obesity 35: 810-819 |
| **Reduced cholesterol** | Kernel fibre | Hall, RS *et al.* (2005). Lupin kernel fibre enriched foods beneficially modify swerum lipids in men. Journal of Clinical Nutrition 59: 325-333. |
| | Protein isolate | Weisse, K *et al.* (2010). Lupin protein compared to casein lowers the LDL cholesterol:HDL cholesterol-ratio of hypercholesterolemic adults. Eur. J. Nutrition 49: 65–71. |
| | Protein isolate | Sirtori C *et al.* (2012). Hypocholesterolaemic effects of lupin protein and pea protein/fibre combinations in moderately hypercholesterolaemic individuals. British Journal of Nutrition 107: 1176-83. |
| | Protein isolate | Bähr M *et al.* (2013) Lupin protein positively affects plasma LDL cholesterol and LDL:HDL cholesterol ratio in hypercholesterolemic adults after four weeks of supplementation: a randomized, controlled crossover study. Nutrition Journal 12: 107 |
| | Protein isolate | Bähr M *et al.* (2015). Consuming a mixed diet enriched with lupin protein beneficially affects plasma lipids in hypercholesterolemic subjects: a randomized controlled trial. Clinical Nutrition 34: 7-14. |
| | Kernel fibre | Fechner, A *et al.* (2014). The formation of short-chain fatty acids is positively associated with the blood lipid-lowering effect of lupin kernel fiber in moderately hypercholesterolemic adults. J. Nutr. 144: 599–607. |
| **Bowel Health** | Kernel fibre | Johnson S *et al.* (2006). Lupin kernel fibre foods improve bowel function and beneficially modify some putative faecal risk factors for colon cancer in men. British Journal of Nutrition 95(2): 372-8 |
| | Kernel fibre | Fechner A *et al.* (2013). Effects of legume kernel fibres and citrus fibre on putative risk factors for colorectal cancer: a randomised, double-blind, crossover human intervention trial. Nutrition Journal 12: Article number 101. |
| | Kernel fibre | Fechner, A *et al.* (2014). The formation of short-chain fatty acids is positively associated with the blood lipid-lowering effect of lupin kernel fiber in moderately hypercholesterolemic adults. J. Nutr. 144: 599–607. |
| **Prebiotic** | Kernel fibre | Smith SC *et al* (2006). Lupin kernel fiber consumption modifies fecal microbiota in healthy men as determined by rRNA gene fluorescent in situ hybridization. Eur J Nutr. 45:335-41 |