

Lupin – A New Super Food

Due to lupin's unique nutritional value, chemical composition and health benefits, commercial food applications have been developed during the last few years.

by Prof. Vijay Jayasena, Dr. Syed Nasar-Abbas and Dr. Ranil Coorey

Lupins are grown throughout the world including Australia, Poland, Chile, US, Russia and Africa. Lupin is an environmentally friendly crop with natural resistance to drought, insects and diseases, and can be grown under marginal agricultural conditions. The crop fixes atmospheric nitrogen and requires less water, fertilizer, and pesticides. Based on the current market price, lupin is much cheaper than other similar grain legumes e.g. soybean.

At present, lupin is mainly used for animal feed with less than 10% of the world production used for human consumption. However, due to its unique nutritional value, chemical composition and health benefits, commercial food applications have been developed during the last few years. When compared to the commonly used wheat and rice flours,

sweet lupin flour has exceptional nutritional composition by consisting of around 40% protein (with balanced amino acid profile), 30% dietary fiber, 6% fat (mainly unsaturated fatty acids) and 1% starch (table 1). Lupin is a good source of bioactive compounds including phytoestrogen, phytosterol, and bioactive peptides; and some of the essential micro-nutrients such as iron, zinc, calcium and phosphorus which are associated with health benefits.

Ingredient Potential

There are bright prospects for lupin to be used as a food ingredient. Lupin based foods are attractive to both developed and developing nations. Obesity, diabetes and cardiovascular diseases (CVDs) are some of the main current health challenges in developed countries. The consumption of unhealthy (junk) foods, which are low in

dietary fiber, low in protein, high in oil and high in starch, is one of the main reasons for these health problems. Independent studies conducted in various parts of the world have shown that the consumption of lupin enriched foods reduces obesity, reduces the risk of type II diabetes, lowers blood cholesterol and improves bowel health and lowers hypertension. The development of novel healthy foods (high dietary fiber, low starch, low GI, etc.) with good consumer acceptability is paramount to address obesity, diabetes and CVDs. Obesity has already reached epidemic level globally with around 1 billion of adults overweight. A significant proportion of the population in developed countries consumes less than the Recommended Dietary Intake (RDI) of dietary fiber, which is one of the major causes of many health problems, including obesity. Hunger and malnutrition due to the lack of availability and/or affordability of basic foods (Especially protein rich foods with balanced amino acids profile) are among the main public health problems

in many developing countries. Protein-rich foods are expensive and unaffordable to most of the population and lack of protein in the diet is the major and common source of malnutrition. It is estimated that around 1 billion hungry/undernourished people are living in the world. Lupin, due to its unique nutritional value, low cost, and ability to grow under marginal agricultural conditions, has the ability to address global malnutrition and provide sustainable food production for future food security. The incorporation of lupin in food formulations to produce foods with good consumer acceptability is a challenging task due to the exceptional chemical composition, including high dietary fiber and low starch contents. Researchers at Curtin University in Australia have developed innovative ways of manufacturing lupin enriched foods with good consumer acceptability by ingredient manipulation and process optimization.

Health Benefits

In recent years consumer demand for alternative food

Table 1: Nutritional Value of Lupin Flour as Compared to Wheat and Rice Flours

Contents (per 100g)	Lupin Flour	Wheat Flour	Rice Flour
Energy (kJ)	1074	1443	1527
Protein (g)	40	10	6
Fat (g)	6	1	1
Dietary fiber (g)	30	4	1
Starch (g)	1	72	80
Potassium (mg)	970	162	148
Phosphorus (mg)	310	130	211
Magnesium (mg)	172	34	52
Calcium (mg)	86	21	7
Iron (mg)	4.1	2.1	0.2



A selection of snacks containing lupin as an ingredient.

ingredients that deliver health benefits such as weight loss, anti-oxidative activity, anti-cancer and anti-diabetic has significantly increased. The satiating power of foods, that is their effect on reducing the appetite, has been recognized by health professionals as one of the most important factors in reducing obesity. Research conducted by Archer et al. (2004) and Lee et al. (2006) has shown that the consumption of lupin containing foods improved satiety, indicating that lupin rich foods can be used to reduce weight loss.

Lupin significantly lowers the levels of both plasma cholesterol and triglycerides (Arnoldi, 2008, Hall et al., 2005a). Fontanari et al. (2012) and Spielmann et al (2007) also demonstrated that lupin was strongly associated with reducing total cholesterol, plasma non-HDL cholesterol and triglycerides.

Lupin flour is rich in protein and dietary fiber, low in starch; and contains a wealth of phytochemicals such as phytic acid,

tannins and saponins, which may act as hypoglycaemic agents compared to starch rich wheat and rice based foods. Hall et al. (2005b) and Johnson et al. (2003) concluded that lupin has GI reduction effect and lengthened the perception of satiety. Terruzzi et al. (2011) and Capraro et al. (2011) reported that some of the proteins present in lupin has the capability to lower blood glucose levels which may help treat diabetes and other related insulin resistant illnesses. Such reductions in glucose and insulin responses are beneficial in the control of Type II diabetes. Lee et al. (2009) and Belski et al. (2011) concluded that lupin flour may be a simple dietary approach to help reduce blood pressure and cardiovascular risk.

Lupins are rich in raffinose family oligosaccharides (Non-digestible carbohydrates) which act as probiotics within the human gut. Martinez-Villaluenga et al. (2008) observed an increase in the bifidobacteria. an

important good gut health bacteria, with oligosaccharides consumption. The study showed that probiotic organisms could utilize the oligosaccharides in lupin for its growth and in-turn provide health benefits to the consumer. Rubio et al. (1995) found that lupin consumption results in an increase in probiotic organisms in the large intestine. Johnson et al. (2006) concluded that the consumption of lupin provide protection from colon cancer. In addition, Confine et al. (2010) and Zacherl et al. (2011) found that the lupin fiber has the capacity to bind bile acids which in turn reduces the risk of colon cancer.

Food Applications

Due to its unique composition with good functional properties and health benefits, there is a great need for incorporating lupin flour into commonly consumed foods such as bakery products, pasta, noodles, snacks and breakfast cereals. Lupin flour has an at-

tractive color (light yellow) but the characteristic unfavorable taste/ flavor and poor texture (mainly due to high dietary fiber content) make its incorporation in food formulations a difficult task. There are a lot of previous attempts to develop lupin enriched foods but low levels of lupin incorporation has been achieved (e.g. up to 5% in bread and 10% in biscuits) and have resulted in hardly any commercial successes. However, a Food Science and Technology research team at Curtin University in Australia made the breakthrough and developed a variety of lupin based commercially viable products with higher levels of lupin incorporation (Jayasena et al., 2009). These foods have a good consumer acceptability rating among Western and Asian consumers.

Lupin bread, biscuits and breakfast cereals with more than 20% lupin contents are commercially available in Australia and will be available in overseas markets in the near future. In

collaboration with the Indonesian Institute of Sciences (LIPI), lupin incorporated tempe (a fermented food product commonly consumed in Asian countries such as Indonesia) with good consumer acceptability has been developed. Tempe is traditionally made out of soybean and incorporation of lupin created a challenge for its fermentation. The inoculum used for soybean fermentation was not suitable for lupin fermentation.

A new inoculum capable of fermenting lupin and producing good quality tempe was developed. By using a new inoculum and manipulating the method, up to 60% lupin incorporation in tempe was achieved (Jayasena et al., 2007) without deteriorating the consumer acceptability.

Lupin incorporated tempe is better in nutritional value by containing less fat and more dietary fiber than the conven-

tional tempe. The lupin based tempe has been commercially launched in Indonesia and a patent has been granted. A great deal of cost reduction can be achieved by replacing soybean with lupin in tempe, since lupin is significantly lower in price than soybean.

The team also successfully developed lupin incorporated tofu, a popular soybean based food in many Asian countries such as Malaysia, China and Japan. A high level (up to 30%) of lupin incorporation was achieved without significantly affecting the acceptability of the product (Jayasena et al., 2010b).

Emerging Areas

Other food products developed by lupin incorporation include pasta, instant noodles, biscuits, muffins, breakfast cereal and crisps/chips (Jayasena et al., 2009, Jayasena and Nasar-

Abbas, 2012, Jayasena et al., 2010c, Jayasena and Nasar-Abbas, 2011, Nasar-Abbas and Jayasena, 2012).

Pasta and noodles are widely consumed throughout the world and are considered as staple food in many European and Asian countries but poor in nutritional value by having low protein, low dietary fiber and high starch contents. Up to 20% lupin flour incorporation in pasta and noodles was achieved without deteriorating the consumer acceptability (table 2), which resulted in double the amount of protein and three times more dietary fiber (figure 1).

Some lupin based foods such as lupin crisps/chips could be used as a replacement to some of the popular junk foods such as potato and other types of chips. A significant improvement in nutritional value, while reducing the production cost, can be

achieved by substituting with lupin.

For example lupin crisps/chips, contain 6 times more dietary fiber, 3 times more protein (figure 1) but 50% less fat and 40% less energy. Lack of dietary fiber consumption is a worldwide problem and has been associated with some of the main health problems. The consumption of 100g lupin crisps/chips is sufficient to get 50% of the RDI (Recommended Dietary Intake) of dietary fiber.

Novel Process

The Curtin team was also successful in replacing 20% wheat flour with lupin flour in biscuits/cookies and muffins which are very popular snack foods in many parts of the world.

Replacing 20% wheat flour with lupin flour resulted in 80% more protein and 150% more dietary fiber along with significant reduction in starch content without any significant effect on the consumer acceptability (table 2).

To use the specific functional properties of lupin, a simple, low cost and environmentally friendly fractionation process has been at Curtin University. This process can be used to fractionate the lupin flour into protein rich fraction (lupin protein isolate) (Jayasena et al., 2011) and dietary fiber rich fraction (lupin dietary fiber).

It has been found that the functional properties such as emulsion capacity, emulsion stability, water holding capacity, foaming capacity and foaming stability of the lupin protein isolate was superior to those of soy protein isolates (Jayasena et al., 2010a, Jayasena and Coorey, 2006). These functional properties make it a very valuable ingredient for use in the food industry.♦

Prof Vijay Jayasena, Dr Syed Nasar-Abbas and Dr Ranil Coorey, Food Science & Technology work for the School of Public Health, Curtin University, Perth, Australia.

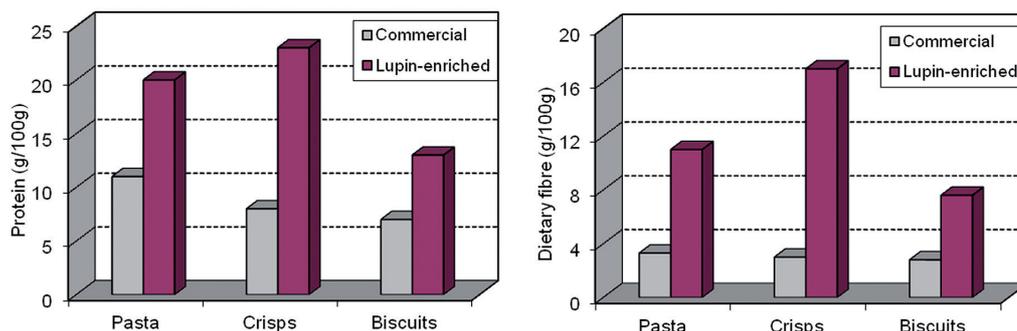


Figure 1: Effect of Lupin Flour Addition on the Protein and Dietary Fiber Contents of Chips/Crisps (Containing 50% Lupin Flour) and Pasta & Biscuits (Containing 20% Lupin Flour)

Table 1: Nutritional Value of Lupin Flour as Compared to Wheat and Rice Flours

Food	Lupin Incorporation	Color	Taste	Flavor	Texture/Mouthfeel	Overall Acceptability
Muffins	0%	5.4	6.2	6.2	5.8	6.3
	20%	6.8	6.5	6.2	6.6	6.4
Biscuits	0%	5.2	7.2	6.8	7.6	6.9
	20%	6.6	6.1	6.1	7.1	6.5
Pasta	0%	7.0	7.4		7.2	7.5
	20%	6.5	6.2		6.0	6.7
Instant Noodles	0%	4.7	6.0	5.5	6.4	6.0
	20%	6.2	5.7	5.7	5.6	5.7
Tofu	0%	6.1		6.2	6.2	6.2
	30%	6.4		6.2	6.4	6.4