OPPORTUNITIES FOR THE USE OF LUPINS IN ASIAN FOODS AND ANIMAL FEEDS

Soon-Bin Neoh

Soon Soon Oilmills, 2425, Lorong Perusahaan 2, Prai Industrial Estate, 13600 Prai, Penang, Malaysia

Email: neohsb@soonsoongroup.com

ABSTRACT

Lupins (*Lupinus angustifolius*) have been suggested as a potential substitute for soybeans in Asian Food. Much research has been done using lupin as a substitute for soybean in soy milk and tofu. Furthermore lupin is a high protein seed and has a low Glycemic Index and in clinical trials it has been shown to reduce the risk of diabetes and cardiovascular diseases. Therefore the potential of using lupins as a nutraceutical food supplement and additive in Asian Foods is tremendous. Our own investigation has shown that dehulled lupin flour can improve the colour, water absorption, protein level and eating qualities of noodles, and in instant noodles we also see a reduction in fat content. Meat sausages, especially chicken frankfurters are very popular in Asia. Traditionally, soy isolates, concentrates and soy flour are used for cost and functional reasons. We have also investigated the use of dehulled lupin flour in sausage making.

The use of dehulled lupins in aquaculture is well documented. In general, dehulled lupin will perform better than soybean meal in most aquatic species. Therefore aquaculture offers the best potential for lupins in animal feeding. However the protein level is not high enough for carnivorous aquatic species. We are researching into making a lupin concentrate. The use of lupin in pig feeding is well documented. Using a dehulled lupin meal processed to maximise nutrient release, we had been able to significantly improve the performance of pigs by replacing 75% of soybean meal in the diets. Feed Conversion Ratios improved by 16%. Our experience with the use of dehulled lupin in poultry has not been promising probably due to the high NSP in the lupin.

KEYWORDS

lupin, noodles, glycaemia index, sausages, dehulled lupin meal and pigs

INTRODUCTION

Soybean has been used in Asian food for thousands of years. Soy milk, tofu, and fermented soybean products have been in the staple diets of many Asian countries. There is much speculation and evidence that soybeans can improve the general health of populations that consume these soy based products. Today FDA allows health claims for soy foods. Therefore the potential of lupin replacing part of the soybean usage in Asia is tremendous. Much work has been done by Dr Mark Sweetingham and colleagues using lupin to produce soy milk, tofu, miso, shoyu and tempeh.

The lupin seed is high in protein, high in dietary fibre, low in oil content and contains minimal starch. It has the lowest Glycemic Index (GI) of any commonly consumed grain. Lupins have been shown in clinical trials to reduce the risk of diabetes and cardiovascular disease. Lupin flour incorporated into white bread significantly reduced the level of blood glucose (Hall, R.S. *et al.* 2005a). Lupin fibre acts as a soluble fibre and reduces the total cholesterol without affecting the HDL cholesterol. Another study found that a lupin-enriched diet can lower total blood cholesterol and LDL cholesterol by 4.5% (Hall, R.S. *et al.* 2005b). In additional, lupin foods can improve bowel health because it reduces transit time, lowers the colon pH (anti cancer) and acts as a 'pre-biotic' to improve bowel functions (Johnson, S.K. *et al.* 2006).

Although replacing soybeans in Asian foods is an obvious use for lupins, lupin flour and lupin fibre can offer functional advantages in Asian foods such as noodles. We have undertaken research in this area and the results are promising (Tables 2 and 3).

(A) USE OF LUPIN FLOUR IN INSTANT NOODLES

- Improved noodle appearance (brighter colour).
- Improved eating qualities (smoother mouth feel).
- Reduces fat content by 3.0%.
- Increases protein level by 0.7% in instant noodles.

Table 1. Flour sample analysis.

	Control	Added 4 % lupin flour
Moisture (%)	13.0	13.0
Protein (%)	11.0	12.0
Ash (%)	0.51	0.60
Farinograph Water absorption (%)	63.5	64.5
Colour, L (brightness)	91.30	91.57
b (yellowness)	9.89	11.34

IN J.A. Palta and J.B. Berger (eds). 2008. 'Lupins for Health and Wealth' Proceedings of the 12th International Lupin Conference, 14-18 Sept. 2008, Fremantle, Western Australia. International Lupin Association, Canterbury, New Zealand. ISBN 0-86476-153-8.

Table 2. Instant noodles analysis.

	Control	Added 4 % lupin Flour
Moisture (%)	4.9	4.3
Protein (%)	10.2	10.9
Oil (%)	19.3	16.3
Colour, L (brightness)	74.12	74.95
b (yellowness)	18.95	22.06

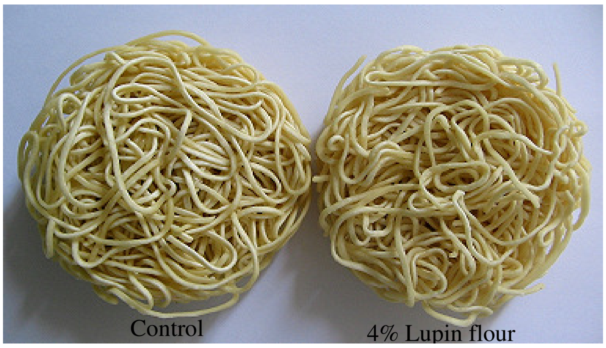

Fig. 1. Instant noodles.

(B) USE OF LUPIN FLOUR IN WANTON NOODLES

- Improved eating qualities (firmer).
- More yellowish colour.
- Darker noodle colour after 24 hours (negative).

Table 3. Wanton noodles colour.

Day	Control		Added 2 % lupin flour	
	2 hours	24 hours	2 hours	24 hours
Colour				
L (brightness)	72.11	68.84	71.02	65.99
b (yellowness)	20.28	22.99	22.12	23.74

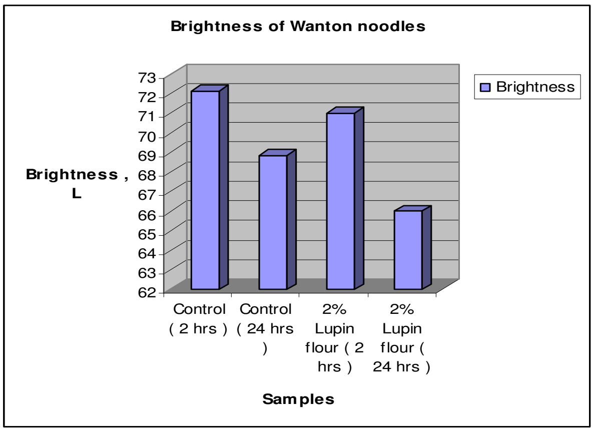

Fig. 2. Brightness.

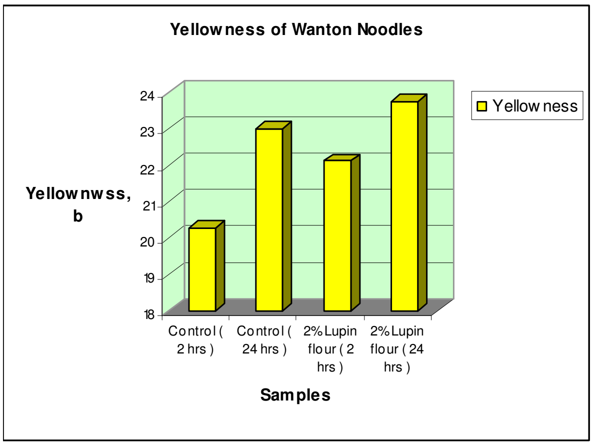

Fig. 3. Yellowness

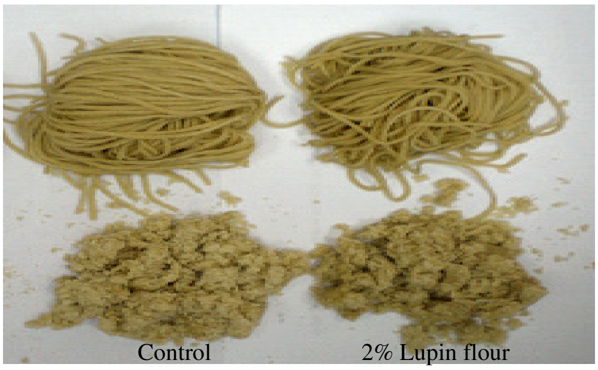

Fig. 4. Wanton Noodles (at 2 hours)

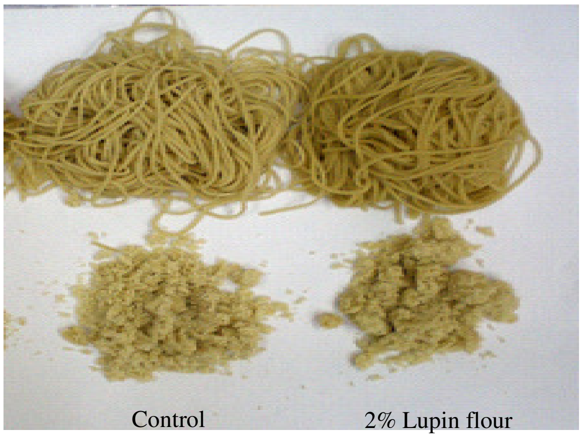

Fig. 5. Wanton Noodles (at 24 hours).

(C) MEAT EXTENDER

Meat sausages are very popular in Asia. In recent years, the consumption of chicken frankfurters has increased tremendously. Normally soy isolates are used for its emulsification properties but some soy flour and soy concentrates have been used to extend the meat protein and increase moisture retention after cooking. We have tested the use of lupin flour in chicken frankfurters.

The use of lupin (*L. angustifolius*) flour in sausages compared with defatted soy flour and control (without lupin or soy flour) results in:

- Darker sausage colour.
- Insignificant difference in eating qualities.
- No shrinkage was observed after cooking.
- Significant increase in moisture retention after cooking.

Table 4. Analysis results for sausages (before cooking).

	Control	Added 5% lupin flour	Added 5% defatted soy flour
Moisture (%)	55.3	60.4	61.5
Oil content (%)	4.19	5.36	2.92

Fig. 6. Flour sample.

Lupin flour can be used for extending chicken meat in frankfurters. The result is a sausage that is indistinguishable in taste from the control and the sausage using soy flour (Fig. 7). After cooking the sausage using lupin flour has a significantly higher moisture content when compare to control and is similar to the product using soy flour (Fig. 8). Therefore lupin flour is suitable for use in sausages to extend chicken meat.

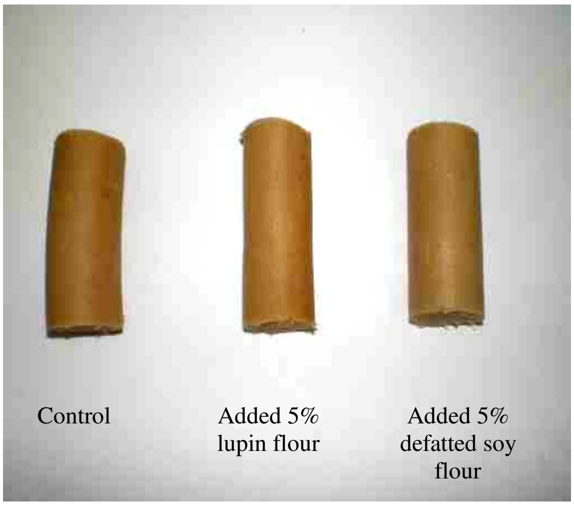

Fig. 7. Sausages (before cooking).

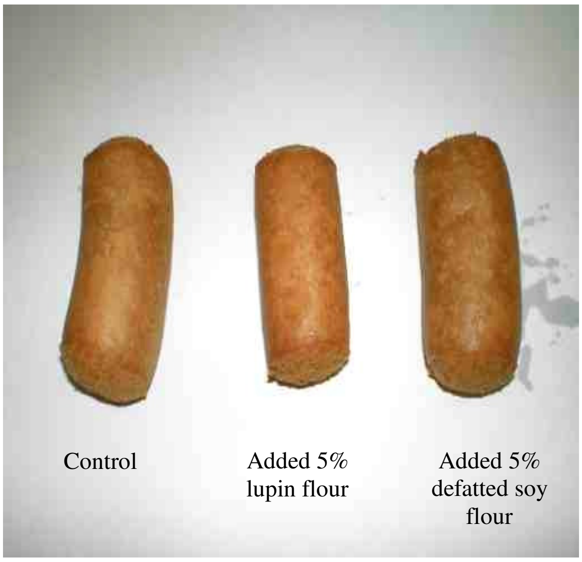

Fig. 8. Sausages (after cooking).

CONCLUSIONS TO NOODLES AND SAUSAGES

Sweetingham and colleagues has shown that lupins can replace soybeans in soy foods such as soymilk, tofu, tempeh, miso, etc.

Our own research shows that lupin flour can improve the eating quality of instant noodles while reducing the oil content and increasing the protein content at the same time. Lupin flour can also be used as a meat extender in sausages with a similar performance to soy flour. The consumption of instant noodles and meat sausages are increasing rapidly in Asian countries. Therefore these two products can offer big opportunities for lupin flour.

In recent years almost all the soybeans grown in the USA and Argentine are genetically modified (GMO). There is much consumer resistance to GMO foods. Lupins are non GMO and therefore it can be a cost effective non GMO replacer for soybeans.

ANIMAL FEEDS

More than 90% of the world Aquaculture production is in Asia (Chart 1). Therefore the potential use of lupins especially yellow lupin (*Lupinus luteus*) is almost unlimited. The protein content of lupins is generally lower than soybean meal (Table 5). However, in most aquatic species lupin protein is more digestible than soybean protein. Although the protein content of dehulled yellow lupin is close to soybean meal, its essential amino acids content is inferior to soybean meal (Table 5). The better protein digestibility of lupin over soybean meal could be attributed to the fact that lupins do not have significant amounts of anti-nutritional factors such as lectins and trypsin inhibitors unlike soybean meal which has to be heat treated to destroy these anti-nutritional factors. During this heating process, the reactive amino groups in the protein can react with sugars present to form maillard type complexes which are indigestible.Glencross *et al*. has done much work on the use of lupins in aquaculture. However in order to commercialise lupins in aquaculture it has to be dehulled and micronised. Unfortunately, dehulling equipments are not available in most Asian Feedmills. The hulls present a problem as in many Asian countries where the ruminant industry is not well developed. However many Australian companies are now starting to dehull and micronise lupins.

The use of lupins in swine feedings is well documented. Generally an inclusion rate of 10-35% is recommended. In most cases the lupins are hammer-milled and used as an ingredient in swine feeds. We feel that the full potential of lupins in monogastric diets is not fully exploited, partly because it is assumed that the high NSP and alkaloid content will cause problems. We have conducted a feeding trial where 75% of the soybean meal is replaced with a dehulled lupin meal that is specially process to release nutrients.

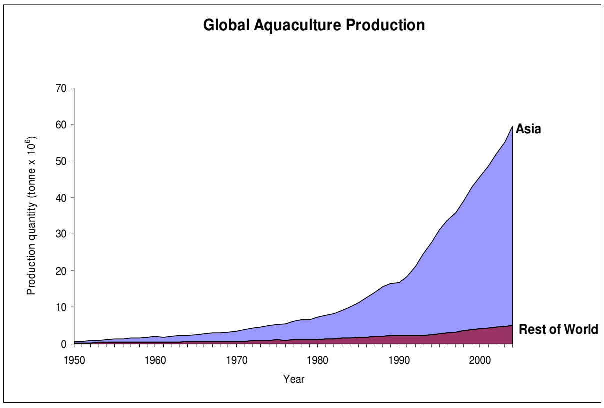

Chart 1. Global aquaculture production 1950-2005.
Source: FAO, Rome.

Animal Trials

A grower pig trial was commenced in a commercial farm in Malaysia. Sixty pigs (Landrace x Large White x Duroc) with an initial body weight of approximate 20 kg were used. They were divided into two groups whereby each group consisted of ten replications and three pigs in each pen. One group was used as a control group which was offered a diet formulated from imported Argentinean non-dehulled soybean meal. Another group was offered a diet whereby 75% of the soybean meal was replaced by a dehulled lupin meal (*L. angustifolius*).

The trial was conducted for eight weeks. Average feed intake was measured weekly for each pen, and the body weight gain for each pig was measured every two weeks. The results were analysed statistically using One Way ANOVA analysis. The diets compositions and their calculated nutrients were presented in Table 6 and Table 7.

The total live weight gains and feed conversion ratios are presented in Table 8. The results show that the differences between the initial body weight, total live weight gain and final body weight were not statistically significant ($P > 0.05$). However the feed intake and feed conversion ratio for the pigs offered lupin diet were significantly lower ($P < 0.05$) when compared to the control group. An improvement of 13.6% was recorded. This is equivalent to an extra 15.8% more liveweight gain per metric ton of feed used. These results showed that the pigs utilised the feed containing the lupin meal more efficiently. This trial demonstrated that dehulled lupin meal can effectively be used to replace soybean meal at high level with improved feed utilisation.

CONCLUSIONS TO ANIMAL FEEDS

Lupins have tremendous potential in Asian aqua and pig feedings. Existing research shows that when correctly processed, it can perform equal or better than soybean meal. In recent years the supply of lupins from Australia has been inconsistent due to drought conditions. This is a big deterrent to the use of lupins for animal feeds in Asia. Furthermore lupins have to be dehulled and micronised to be effectively utilised, especially in the aquaculture industry. Most Asia Feedmills do not have the required equipment. Yellow lupin has the greatest potential but supply is very limited.

REFERENCES

Hall, R.S. *et al*. 2005a. Australian sweet lupin flour addition reduced the glycaemia index of white bread breakfast without affecting palatability in healthy human volunteers. Asia Pacific J. Clinical Nutrition 14: 91-97.

Hall, R.S., S.K. Johnson, A.L. Baxter and M.J. Ball. 2005b. Lupin kernel fibre-enriched foods beneficially modify serum lipids in men. European Journal of Clinical Nutrition 59: 325-33.

Johnson, S.K., V. Chua, R.S. Hall and A.L. Baxter. 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.

Coffey, R. 1989. 'Lupin as an energy-rich protein source for feed and food' in vegetable protein utilisation in human foods and animal feedstuffs. Ed. Th Applewhite pp. 410-414. American Oil Chemists Society, Champaign, Illinois.

G. dervas, G. Doxastakis, S. Hadjisavva-Zinoviadi and N. Triantafillakos. 1999. Lupin flour addition to wheat flour doughs and effect on rheological properties. Food Chemistry 66: 67-73.

Table 5. Nutrient composition of feed ingredients.

Nutrient	Fishmeal	Wheat gluten	Yellow lupin *(L. luteus)*	White lupin *(L. albus)*	Sweet lupin *(L. angustifolius)*	Soybean meal	Pregel starch
Dry matter content (g/kg)	925	910	937	922	910	890	870
Crude protein (g/kg DM)	703	838	496	455	411	503	10.1
Total nitrogen (g/kg DM)	112	134	79	73	66	80	1.6
Crude fat (g/kg DM)	105	9	55	137	60	12	1.1
Ash (g/kg DM)	216	8	38	36	32	88	2.3
Nitrogen-free extractives (g/kg DM)	8	146	410	405	497	397	857
Phosphorus (g/kg DM)	40	1	5	5	4	7	1.4
Gross energy (MJ/kg DM)	19.6	22.6	21.0	23.1	20.7	19.2	15.1
Lysine (g/kg DM)	57.4	13.2	22.8	19.5	18.1	33.9	n/a
Threonine (g/kg DM)	34.3	21.9	15.7	16.4	14.4	22.7	n/a
Methionine (g/kg DM)	20.5	13.8	3.8	3.0	3.1	8.4	n/a
Isoleucine (g/kg DM)	31.5	29.2	16.3	18.7	16.3	24.9	n/a
Leucine (g/kg DM)	55.6	57.5	35.4	31.4	27.7	42.1	n/a
Valine (g/kg DM)	39.2	33.5	16.7	17.5	15.7	26.9	n/a
Phenylalanine (g/kg DM)	29.8	42.5	18.1	16.7	16.4	28.1	n/a
Histidine (g/kg DM)	31.1	18.7	13.8	11.0	11.6	15.5	n/a
Arginine (g/kg DM)	43.0	27.8	47.0	51.8	44.3	39.8	n/a

Source: Fisheries Research Contract Report, 2003.

Table 6. The compositions of trial diets.

Ingredients	Control diet	Lupin diet
Corn, g/kg	578.7	578.7
Argentinean soybean meal, g/kg	225.5	0
Soon Soon soybean meal, g/kg	0	56.4
Dehulled Lupins meal, g/kg	0	169.1
Wheat pollard, g/kg	129.5	129.5
Fish meal 60, g/kg	30	30
Limestone, g/kg	11.1	11.1
Crude palm oil, g/kg	10	10
MDCP, g/kg	8	8
Vitamin Premix, g/kg	4.2	4.2
Salt, g/kg	2.5	2.5
L Lysine, g/kg	0.3	0.3
L Throenine, g/kg	0.1	0.1
Choline Chloride, g/kg	0.1	0.1

Table 7. The calculated nutrients of the trial diets which are iso caloric and iso nitrogenous.

Nutrients	Control diet/lupin diet
Metabolisable Energy, Mj/kg	12.97
Crude Protein, g/kg	174
Crude fat, g/kg	42
Lysine, g/kg	9.49
Methionine, g/kg	0.297
M + C, g/kg	0.595
Tryptophan, g/kg	0.20
Threonine, g/kg	0.664
Dig. Lysine, g/kg	0.792
Dig. Methionine, g/kg	0.256
Dig. M + C, g/kg	0.478
Dig. Tryptophan, g/kg	0.162
Dig. Threonine, g/kg	0.523

Table 8. The growth performance of grower pigs fed with control diet and lupin diet.

	Control diet	Lupin diet
Initial body weight (kg)	21.93 ± 0.73^a	22.21 ± 0.63^a
Average feed intake (kg/day/pig)	1.59 ± 0.06^a	1.36 ± 0.05^b
Final body weight (kg)	53.93 ± 1.71^a	53.42 ± 1.47^a
Total Live weight gain, g/day/pig	571.43 ± 16.18^a	563.90 ± 17.15^a
Feed conversion ratio	2.79 ± 0.10^a	2.41 ± 0.09^b

Values with different superscripts within rows differ significantly from each other at 95%.