

# GRAIN LEGUMES IN THE HUMAN DIET

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## ABSTRACT

Although they have traditionally had limited use in the New Zealand diet, legumes have a very long agricultural history. Today they are still a vital source of protein in many regions and are a traditional food item in Europe and in the Mediterranean. As a staple food, they make a significant nutritional contribution to the diet. From a nutritional perspective, legumes are high in protein and low in fat and reflect the current nutrition guidelines for all New Zealanders, which are to eat a diet lower in fat and containing less animal protein. Legumes are also high in fibre, a nutrient lacking in many New Zealanders' diets, yet essential for health.

*Additional Key Words: Glycaemic index, nutritional value, recipes*

## PROTEIN

The average New Zealander often eats 50 - 100 % more protein than their bodies can utilize - usually in the form of meat.

Legumes do have deficiencies in their amino acid profile which make them generally less usable by the body than animal protein. However, these amino acid deficiencies can be matched with the amino acid strengths in other plant foods to provide protein of good biological value. This matching is called 'protein complementarity'.

For example, when beans and wheat are eaten together, their respective amino acid deficiencies are supplemented by the surplus amounts present in the other seed. For example the lack of lysine in the cereal is supplemented by the beans and the lack of methionine in the beans is supplemented by the wheat, thus the biological value of the protein of the two seeds is increased. (Figure 1).

## FATS

Legumes provide protein without fat, unlike animal protein. The National Heart Foundation is encouraging New Zealanders to reduce their fat intake, especially animal fat to 35 % of total energy intake, and to reduce it to 30 % of total energy by the year 2000.

The 1980 National Dietary survey showed that 41 % of daily energy comes from fat alone. A 10 - 15 % reduction in fat consumption is a major dietary behavioural change. The inclusion of legumes to partially replace meat as a source of low fat protein in the diet would facilitate this change.

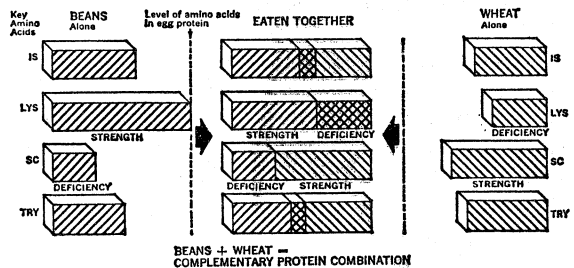


Figure 1. The amino acids from beans and wheat complement each other (from FAO, 1970)

## CARBOHYDRATES

Beans are a rich source of complex fibrous carbohydrates. New Zealanders are being encouraged to eat more complex carbohydrate. In dietetic practice

legumes are referred to as lente carbohydrates or carbohydrates with a low glycaemic index.

### Glycaemic Index:

$$GI = \frac{\text{blood glucose test food} \times 100}{\text{blood glucose of reference. food}}$$

The glycaemic index study of 78 individual foods demonstrates the lower glycaemic index of legumes (Figure 2)(Thorburn *et al.*, 1986).

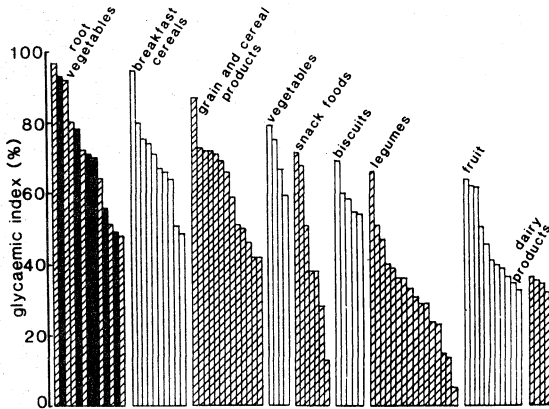


Figure 2. The glycaemic index of 78 individual foods. (From Thorburn *et al.*, 1986).

Diets high in complex carbohydrate which emphasise those foods with a low glycaemic index but low in fat, significantly improve glycaemic and metabolic control in the management of diabetes mellitus a disorder affecting approximately 5% of New Zealanders.

## FIBRE

Legumes are particularly rich in dietary fibre. Dietary fibres can be classified by their solubility in water, since water soluble and water insoluble fibres have distinct physiological effects.

### Water solubility of fibres

Insoluble fibre (Structural)

- Lignin
- Cellulose

Some hemicelluloses

Soluble fibre (gel forming)

- Pectins
- Gums
- Mucilages
- Remaining hemicelluloses

Most foods of plant origin contain both soluble and insoluble fibres, but they tend to be rich in either one or the other. Citrus fruits, oats, barley and legumes contain more soluble fibre. Oats and beans, as opposed to lentils and peas, are especially good sources of gums - gel forming fibres.

The consumption of diets rich in plant foods is inversely related to the incidence of a variety of life-style related disorders.

### Physiological effects of soluble fibre

1. Increased viscosity of the stomach contents.
2. Delayed gastric emptying.
3. Slower rate of digestion and absorption of nutrients in the upper intestinal tract.
4. Decreased intra-luminal colonic pressure.
5. Increased stool volume and weight.
6. Increased production of volatile fatty-acids.
7. Altered bile salt metabolism.

The effect of delayed gastric emptying may assist with control of body weight, since an increased feeling of fullness promotes satiety. Diets high in soluble fibre lower serum insulin, enhancing satiety, since insulin stimulates appetite. The slower rate of digestion and absorption of nutrients slows absorption of glucose from the intestinal tract, improving glycaemic control in diabetes.

Constipation is a major problem in developed countries, including New Zealand, contributing to haemorrhoids, varicose veins and diverticular disease of the colon. Dietary fibre is hygroscopic and softens the stools, resulting in decreased intraluminal pressure and increased stool volume and weight. Soluble fibre when combined with cellulose fibre has a superior bulk forming effect for promoting normal laxation.

The anticarcinogenic effect of fibre is currently under close scrutiny, as the role of fat and fibre has not been clearly defined. However fibre can bind carcinogens by its hygroscopic effect.

Raised serum cholesterol is a major risk factor for heart disease. Soluble fibre lowers cholesterol levels by

binding with bile salts and other blood fats resulting in a reduction in the quantity of cholesterol absorbed by the intestinal mucosa. Resulting in an increased excretion of bile salts in the faeces.

Soluble fibre is fermented by the colonic bacteria to form gases and short chain fatty acids. The latter are almost completely absorbed by the portal vein which may mediate changes in glucose and lipid metabolism.

Current guidelines recommend 20 g of dietary fibre per 1000 K calories. Individuals with diabetes mellitus and those with high cholesterol levels are encouraged to consume nearly half their fibre intake as soluble fibre.

The 1980 National Dietary Survey showed that many New Zealanders need to double, or treble, their intake of dietary fibre, not by adding fibre concentrates but by increasing their intake of complex carbohydrates through the consumption of legumes, fruit, vegetables, whole grain cereals and bread.

The fibre content of cooked legumes per serving is superior to most other complex carbohydrate foods. For example:-

**Foods containing 2.0 g Fibre:**

- 1 thin slice bread (90 % whole meal)
- 4 thin slices bread (white)
- 1/2 cup porridge
- 2/3 cup komies
- 1 apple
- 1 1/2 tablespoons of baked beans
- 1/4 cup lentils

Unless beans are regularly included in the diet it is difficult to reach the recommendation for fibre intake - especially soluble fibre.

Economically, partial substitution of meat with legumes is attractive when the price of New Zealand beef has nearly doubled in recent times (Table 1).

When considering the nutrient needs of an average adult male in a semi-sedentary occupation, 250 g of rump steak exceeds the total daily protein requirement, the fat content represents nearly half the recommended daily intake (30 % of total energy) and supplies 25 % of the recommended daily energy intake.

The beef and bean goulash, by comparison, is significantly lower in fat, provides approximately half the daily protein intake and more than half the recommended fibre intake, especially soluble fibre. This recipe is suitable for inclusion in diets for the weight conscious or the individual with diabetes mellitus or elevated blood cholesterol levels.

From a nutritional perspective, grain legumes in the human diet complement the New Zealand nutrition guidelines - to eat a diet higher in complex- fibre containing carbohydrates, low in fat and with less emphasis on animal protein. However, grain legumes are not indigenous to the New Zealand diet and they continue to be used in a relatively limited way. The question remains - how can New Zealanders be encouraged to include beans in their everyday eating habits?

**Table 1. Comparative cost and nutritive value of 250 g serve of beef and bean goulash compared with fried rump steak.**

	Beef and bean goulash	Rump Steak, (fried)
Cost	\$1.90	\$3.40
Protein	27.0 g	71.5 g
Carbohydrate	40.0 g	0.0 g
Fat	8.0 g	36.5 g
Fibre	16.0 g	0.0 g
K calories	340	615

Barriers to acceptance exist and the task for food growers, manufacturers and retailers is to find ways of overcoming these barriers by appropriate marketing and promotion, and for Dietitians and other food experts to educate the consumer regarding the preparation, cooking and serving of legumes.

**INCORPORATION INTO MEALS**

When a traditional menu sequence is employed, it appears simple to incorporate grain legumes into the New Zealand diet. Pates, purees, and roasted whole legumes can be used as appetisers and pre-meal nibbles or snacks.

Soups can be light-weight adjuncts to a meal, or a meal in themselves, especially when teamed with bread or another grain cereal product.

The theme of a meal-in-a-cup demonstrates the concept of serving legumes or nuts and cereals together at a meal in order to achieve a complementary mixture of essential amino acids. Complementarity is not difficult to achieve, but its importance in terms of adequate nutrition needs to be promoted. So, when educating the consumer in this concept, we should begin

with what people are already doing to put complementarity into action. Baked beans on whole meal toast, or the peanut butter whole meal bread sandwich, are examples which New Zealanders already employ.

Grain legumes can be teamed with meat. Cassoulet, a classic dish of France is a hearty stew of fresh and preserved meats, beans, herbs and tomatoes, which is blended by slow cooking into a satisfying and inexpensive use of small amounts of meat.

Across the other side of the globe, Mexican beans are a traditional dish which can be recycled into another meal as refried beans. The latter can be served as an appetiser or as a main meal, with accompaniments such as salad, and tortilla.

The use of grain legumes does not need to be restricted to the classic dishes of other cultures. A pie crust can be filled with a mixture of red beans and vegetables, bound in a savoury custard.

Lentils require only a short cooking time in order to be reduced to a paste or puree. In this form they can be shaped into patties for pan-cooking or made into the lentil version of a meat loaf. They can also be incorporated into stuffings, dips and spreads for bread or crackers - hummus is one example.

Grain legumes in salads, in both the cooked bean and sprouted form are becoming more popular in New Zealand.

## GENERAL NUTRITIONAL VALUE

Grain legumes are inexpensive, compact and easily stored. They are a rich source of all vitamins, with the exception of Vitamin C and B12 and are a useful source of nutrients such as calcium, iron and other trace elements.

Sprouted beans have other desirable nutrition properties which are different to those of the original legume, such as a higher Vitamin C content, high water content (therefore lower in calories).

High fibre diets are associated with decreased absorption of iron, calcium, zinc and other trace elements.

The current recommendations to increase dietary fibre would not be expected to be high enough to have any significant effect on mineral absorption, providing an adequate intake of the minerals in question is maintained. While fibre may bind with minerals in the duodenum and ileum, there is release of some ions in the large bowel possibly due to the fermentation of

soluble fibre. However, it is important to still include meat in the diet, despite the quest to consume more legumes, as meat is still the most important source of iron, zinc and vitamin B12. The serving of a Vitamin C rich fruit or vegetable at the same meal will ensure the optimal uptake of iron from grain legumes.

## BARRIERS TO LEGUME USE

Barriers currently exist to the acceptance of grain legumes by the average New Zealander.

1. Understanding of the uses of grain legumes has been lost to New Zealand during Colonial and post-Colonial times. The ability of farmers to produce cheap meat, a food which has a high consumer appeal, means that New Zealanders as a group have not been required to extend or supplement a limited meat supply with grain legumes.
2. The image which the average New Zealander has of legumes is that they are time consuming to cook, are visually unattractive and are generally tasteless, boring and antisocial.
3. As the range of convenience foods increases consumers expect to spend less time in food preparation and service and are unlikely to adopt a food which requires lengthy preparation and cooking.

## OVERCOMING BARRIERS

### *Education*

1. Consumers can be informed of the uses to which grain legumes are already being put in the New Zealand menu. Many people are unaware that the meal of baked beans served with bread, plays the same role as more exotic mixtures of grain legumes and cereals.
2. Consumers can be informed of quick and easy ways to achieve the initial cooking of grain legumes, especially those which retain their shape after cooking. These can be frozen once cooked and incorporated into a dish when required.
3. Consumers can be made aware of safe ways of handling grain legumes. The dangers of eating incompletely cooked or soaked, uncooked beans, must be stressed. Consumers need to be made aware that the low acidity content of cooked legumes and lentils makes them vulnerable to bacterial contamination. The same precautions which apply

to meat dishes of covering and refrigeration of cooked beans, or adequate heating before serving, must be observed.

### **Promotion**

In the current health promotion and economic climate an effective marketing and information package could motivate consumers to use grain legumes more freely. Legume cookery can be colourful and varied as a multiplicity of legumes are available.

The creative use of herbs, spices and other condiments adds to their colour and flavour. Three condiments are noted as being especially appropriate for use in legume cookery - dried avocado leaves, fresh coriander and dried oregano, because they are traditionally believed to relieve the digestive side effects of eating legume dishes.

Ways of incorporating grain legumes into staple food items in this country needs to be researched. The use of legume and lentil flour to augment standard bread flours has not been widely promoted in New Zealand, with the exception of a bread enriched with soya meal recently released on to the market.

There needs to be a creative broadening of the basis on which grain legumes can be included in modern eating patterns. Creative solutions need to be found to raise legumes to the status of ready-to-eat, convenience food. However, it will be important to develop products which retain the nutritional qualities of grain legumes as a desired addition to the New Zealand diet. In other words, products would ideally retain some, if not all of the low fat, high fibre qualities of the original legume.

Legume convenience foods exist in other cultures and are beginning to be incorporated into our own diets. Commercially prepared bean sprouts, soya flour and bean curd are three of these. Different legumes, in the form of bean sprouts, have distinctive flavour and texture and can be promoted as snack foods.

## **CONCLUSION**

There is a place for grain legumes in the New Zealand diet, both for reasons of health and of economy. An active educational and promotional campaign which addresses some of the issues raised in this paper may go some way towards raising the profile of grain legumes in this country.

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# EXAMPLES OF LEGUME BASED RECIPES FOR EVALUATION

Dried red lentils were ground finely in an electric coffee/spice grinder and used in place of 10 % of the standard white flour required in the following recipes.

## BASIC BREAD

(modified from *The New Zealand Bread Book*, Browne, et al. (1981)).

### Ingredients:

- 600 ml warm water
- 1 kg white flour
- 1 T dried yeast
- 1 T salt
- 1 T sugar
- 1 T melted butter or margarine

### Method:

1. Add dried yeast and sugar to warm water and leave in a warm place while other ingredients are being prepared.
2. Sift flour and salt together.
3. Add most of the melted butter to yeast and water mixture. Use the rest of the butter to grease the bowl, the top of the dough and the baking tins.
4. Tip most of the flour into the liquid ingredients and stir with a wooden spoon until the mixture becomes too stiff to continue. Use your hands to form the dough.
5. Knead the dough for 7 - 10 minutes on a board, lightly floured with the extra dry ingredients.
6. Place the dough in a greased, lightly greasing the top of the dough with butter.
7. Cover the bowl and leave in a warm place to rest for 15 minutes.
8. Knead the dough lightly, and divide into pieces.
9. Shape as required and place in lightly greased containers.
10. Brush the top of each piece of dough of dough with butter, cover with plastic film, and leave in a warm place to double in size (30 - 60 minutes).
11. Bake in a hot oven 220° C to 230° C for 30 - 35 minutes or 15 - 20 minutes for bread loaves.

A variation which used 10 % red lentil flour did not require modification of the basic ingredients, the

method, the cooking times or the temperature.

The amount of dough in this recipe will produce 2 x 500 g loaves or 20 x 80 g bread rolls.

## DROPPED COOKIES

(From *The Basic Cook Book*, Heseltine & Dow (1935))

### Ingredients:

- 1/2 C butter or other fat
- 1/2 t vanilla
- 1 C sugar
- 2 C flour
- 1 egg, unbeaten
- 1/4 t salt
- 4 T milk
- 2 t baking powder

### Method:

1. Soften butter in a bowl, add sugar, milk, and flavouring and stir thoroughly.
2. Sift flour, baking powder and salt together and stir into mixture in the bowl.
3. Push from a teaspoon onto a well-greased cooking tray.
4. Bake on top shelf in a moderate oven (180° C-200° C) until firm to the touch and delicately brown in colour (8 - 12 minutes).

A variation which used 10 % red lentil flour did not require any alteration to the recipe.

An acceptable variation was to use of 1/4 C each of peanut butter and butter instead of the 1/2 C butter stated along with the 10 % red lentil flour.

## HUMMUS

### Ingredients:

- 1.5 C cooked chick peas
- 2 T tahini (sesame butter) or 2 T sesame seeds and 100 ml plain yoghurt
- Juice of 1 lemon
- Garlic to taste

### Method:

Blend all the ingredients together in a food processor until smooth.