NUTRITIONAL ASPECTS OF LEGUMES

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Contents

Summary

Legumes have been important source of protein, starch, oil, minerals, vitamins and health protecting compounds from the beginning of human history. Their seeds play an important role in the traditional diet of many peoples of the world and are a valuable basic material for the food and animal feed industries.

Legume seeds contain 200-250 g protein/kg; the protein is rich in lysine, and is therefore complementary to cereals in lysine balance. The main protein fractions are albumins and globulins; these fractions are different in their amino acid composition, molecular weight and physico-chemical properties.

Grain legumes with their 390-510 g/kg starch content are important energy sources. The chemical composition of legume starch is characterized by high amylopectin content.

The dietary fibre content of seeds is a very important factor from the nutritional point of view. The oil content of legumes (except soy and lupin) is about 1 to 2%; the oil is composed mainly of polyunsaturated fatty acids.

The commonly present anti-nutritional compounds like protease inhibitors, galacto-oligosaccharides, lectins, saponins, and tannins have partly health- protecting properties but some of them are anti-nutrients that have to be inactivated before use.

The immature pods, green and mature seeds are used for human consumption according to traditional recipes and the mature seeds are the basic material for producing flour, concentrates and isolates. These products are used in the food industry and for animal feeding.

Legumes are typically Mediterranean and subtropical plants, but could be cultivated in temperate climates also. A great benefit of legumes is their N-fixation of atmospheric nitrogen by symbiotic rhizobia. Because of this, annual legume crops are of great value in rotations.

The annual consumption of legume seeds is 2.5 kg /capita in Europe, and higher in other part of the world (5.4 to 14.4 kg).

1. Introduction

The importance of grain legumes in the world is high due to their significance in human and animal nutrition. Legume seeds can also become an industrial basic material with a wide range of non-food applications. In spite of the increasing interest concerning cultivation of pulses, the growth area and production of seeds, their application is relatively small (Kozlowska et al., 1998).

Legumes are a rich source of nutrients such as protein, starch, minerals and vitamins and have also important health protective compounds (phenolics, inositol phosphates and oligosaccharides).

As a result of the advantageous composition of legume seeds they can be used not only as meat replacers but also as components of rational nourishment and food for vegetarians. The isolated proteins, starch and fibers from legume seeds have good physico-chemical and health protecting properties and are promising basic materials for food industrial use.

Leguminous seeds are important in the traditional diet of large populations in many parts of the world, for example soybean in Asia, lentils in India, black bean in South America, chickpea in the Middle East, and pinto bean in Mexico.

2. History, Taxonomy and Distribution

2.1. History

The earliest human-domesticated plants are believed to have been legumes. Grain legumes have been an important part of the social evolution over the past 10 000 years. Carbonised seeds of pea, lentils and vetches have been found in fireplaces of the Neolithic age (7000 to 8000 years B.C.) in Turkey. These seeds formed the basis of food in this region and spread to the north-west and south-west (into Africa) and towards India.

After the early period, the use of legume seeds diversified. In some countries, such as India, legumes remained the main source of protein for economic and social reasons. In other developed countries the use of dry pulses in human diet declined because meat became the more common daily source of protein. Fresh seeds and fresh pods for example of garden peas (*Pisum sativum*) and French beans (*Phaseolus vulgaris*) were used for human consumption instead of dry pulses.

The rapid increase of meat consumption in the world produced a high demand for protein-rich feedstuff. In developed countries soybean meal and other oil seed meals supplied this demand. Soybean is the most important legume in the world; it is cultivated on 60 million hectares. The main producers of soybean are the USA, Brazil, China, and Argentina. The cultivation of soybean in Europe is rather low, other legumes such as pea, bean, lentil, cowpea and lupins playing a more important role in food and feed market.

2.2. Taxonomy

More than 60 domesticated grain legume species belong to the Leguminosae family. The main cultivated grain legumes, their common name as well as Latin name, distribution and their use are listed in Table 1.

Common name	Latin name	Distribution	Consumption
Soybean	*Glycine max L.,*	USA, Brasil, China, Argentina, Japan	Human consumption, mainly processed products (soy meal, concentrate, isolate, soy milk, fermented products) Animal feed
White lupin	*Lupinus albus L*	Europe, America,	Animal feed for poultry, pigs and fish
Yellow lupin	*Lupinus luteus L.*	Europe, America	Animal feed for poultry, pigs and fish
Sweet lupin	*Lupinus angustifolius L.*	Europe, America	Animal feed for poultry, pigs and fish
Chickpea	*Cicer arietinum L.*	Mediterranean countries, South Asia, Eastern and Southern Africa	Green leaves are eaten as vegetable, green seeds in raw, roasted and boiled form. The dry seeds are cooked or canned. Dry leaves are animal feed.
Mung bean	*Vigna radiata L.*	South Asia, China, India	Used as green vegetable or sprouting shoots
Pigeon pea	*Cajanus cajan L.*	India	Human consumption and animal feed
Cluster bean	*Cyamopsis*	India	Young bean are used as

	tetregonoloba		vegetable, the dry beans are used for producing guar gum, it is used in paper and textile industry and for cosmetics and pharmaceuticals
Jack bean	*Canavalia ensiformis L.*	India, Far East, North and East Africa	For human consumption used as vegetable, as dry bean.
Common bean (also called as French, garden, haricot, kidney, pinto, navy (baked bean) black, pink, black eye, cranberry, great northern or dry bean)	*Phaseolus vulgaris L.*	India, Brazil, France, Russia, German, UK, Ukraine	Human consumption green in pods (canning, freezing) or dry seeds,
Faba bean (field bean)	*Vicia faba L.*	Central Asia, Mediterranean countries, South America, Near East, Europe	Human consumption, and canning, freezing The dry harvested seeds are used as animal feed.
Lentil	*Lens culinaris Medicus*	Turkey, Europe (France, Spain), Asia, Canada, USA	Human consumption
Cowpea	*Vigna unguiculata L.*	Mediterranean area, Africa, Asia	Human consumption, it is eaten as dhal made from soaked, dehulled seeds
Pea	*Pisum sativum L.*	Europe, North America,	Human consumption, combining crop for animal feed

Table 1. The main grain legumes, with information on distribution and consumption

2.3. Distribution

There are great differences across the world in the proportions of cultivated legumes. In the USA legumes account for about 16% of the total arable land, in this area soybean is the most economically important crop. In Europe the area of grain legumes is about 4 million ha, in this area 8 million t legume seeds are produced. The dominant legume seed in Europe is pea, which is cultivated on about 1 million ha (Hedley, 2001).

3. Chemical composition

3.1. Legume seeds as a source of protein

The protein content of raw legumes is summarized in Table 2.

Legume	**Protein content, %**
Chickpea	15.5 to 28.2
Lens	24.7
Lupin	34.8 to 62.5
Beans (*Vicia*, *Phaseolus*)	19.4 to 24.8
Peas	23.9 to 25.1

Table 2. Protein content of raw legumes (as % of dry matter)

Legumes are relatively rich sources of protein as the seeds contain 200-250 g protein/kg. The protein content of cooked legume seed (70-100 g/kg cooked food) is similar to that of bread (80-90 g/kg), but still much higher than for potato (15-22 g/kg).

Legume seeds are rich in lysine and poorer in sulfur-containing amino acids (methionine and cysteine) compared to cereals. Lysine is the first limiting amino acid so it is important that legumes complement cereals in lysine balance.

Legume proteins are composed of several thousand specific proteins. About 70 to 80 % of the crude protein in legume seeds is storage protein. The non-storage proteins are enzymes, enzyme inhibitors, hormones, transporting, structural and recognition proteins.

The main protein fractions of legume seeds are **albumin** and **globulin**, which can be separated into two major fractions, **vicilin** and **legumin**. The relative proportion of legumin to vicilin varies with genotype, but vicilin is the major protein fraction in all legumes except *Vicia faba*. Vicilin contains low sulfur-containing amino acids; this is the main cause of the relatively poor amino acid composition of pea (Casey, 1998). The main globulin fractions differ in their amino acid composition, molecular weight of protein subunits and physico-chemical properties.

The albumin fraction has a well-balanced amino acid profile, and is relatively rich in sulfur-containing amino acids.

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Biographical Sketch

Dr. Ildikó Schuster-Gajzágó was born in 1942 in Budapest, Hungary. He is married with one child. From 1961 to 1966 he attended the Eötvös Lóránd University of Sciences in Budapest, attaining an MSc in Biology. In 1985 he was awarded a University Doctoral Degree and in 1997 a PhD in Biology

From 1967 to 1986 he was a Research Worker at Department of Enzymology at the Central Food Research Institute. From 1986 he was a Research Worker in the Department of Technology at Central Food Research Institute, and from 1997 a Senior Research Worker.

His research activities have focused on the following:

1967-1972. Basic and applied research of enzymes (glucose oxidase, milkclotting enzyme of microbial origin, cellulase).

1972-1986. Study of enzymic browning of fruits (apple, pear, apricot) and establishment of the relationship between PPO activity and endogen substratum content. Study of the inhibition of enzymic browning of fruits. Study of the effect of location and year on polyphenoloxidase-polyphenol content of apple.

1986-1998. Enzymic modification of plant protein. Study of the effect of animal and microbial origin protease enzyme on the colloid properties of modified plant protein. (This program was supported by the EU Copernicus project). Study of antinutritional compounds of legume seed (protease inhibitors and oligosaccharides).

1998-present. Study of health protecting compounds such as glucosinolates and polyphenols of legume seeds and mustard. Determination of polyphenol content and composition as well as antioxidant properties of mustard varieties.