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Chapter

Nutraceutical Potential of Seed and Grain Proteins in Health Promotion

Suryapal Singh, Lalita Singh, Harshita Singh and Suman Sangwan

Abstract

In recent years, seed and grain proteins with nutritional bioactivity have been studied for disease prevention and treatments. Seed and grains are key components of a healthy and balanced diet which support the protective role of bioactive proteins with nutraceutical activities. Proteins obtained from seeds can be a good source of amino acids and nutraceutical peptides that can be used for biotic functions to improve health and disease prevention. Hence, the increased consumption of seeds and grains promotes a healthy generation in future and a significant reduction in diseases. To increase the human health awareness, we must have to enlighten the importance of easily available seeds and grains in our food.

Keywords: Seed, grains, proteins, nutraceuticals

1. Introduction

The systematic study of protein grains prolongs back for near about 250 Y, with the separation of wheat gluten first described in 1745 [1]). "TB Osborne" father of plant protein chemistry has been carried out more methodical study of plant proteins in 1859–1929. Cereal grains provide nourishing food globally and food nutritive is essential to all living organisms for function, structure, and regulation of the body. People succeeding an herbal diet need to find no animal sources of protein to ensure they are getting enough nutrients such as Vitamins, Proteins, Minerals and Fibers to prepare their body against diseases. Grains used as protein factories to assist the Nutraceutical and Pharmaceuticals. Seeds and grains enrich in energy as well as factories of essential nutritive fatty acids, flavonoids, bioflavonoids, catechin, epicatechin, quercetin, caffeic acid, coumaric acids, cinnamic acids and many other useful compounds which are used in drug used for the treatment of diseases. Today's generation suffer from infectious, inflammatory, allergic, diabetic, carcinogenic and cardiovascular diseases. Nutraceuticals and drugs are the fastest growing area to cure diseases in humans and other diseases in animals. The production of nutritive elements for nutraceuticals and pharmaceutical applications are very important to save future [2]. Nutraceutical can be well-defined as a food or part of a food that deliver therapeutic and health

aids, with the preclusion and treatment of a disease [3]. Nutraceutical is the combination of "nutrition + pharmaceutical" in broad, are part of food that play a major role in growing and maintaining normal physiological functions that maintains people healthy [4]. Now a day's scientists are focusing on genetic engineering of crops to increase the quantity and quality of protein as a means to produce enormous drugs and vaccines, hoping that this technology can reduce costs and increase the availability of most needed pharmaceuticals and nutraceuticals [5–8]. Seeds and grains-based pharmaceuticals are advantageous because the vaccinated plant tissue can be administered raw, dried, or in an encapsulated form; all forms can be stored and dispatched at room temperature [9]. The risk of contamination with pathogens from animal during production is also removed, [10], moreover seeds-based vaccines can be stored as seeds are beneficial because a lot of vaccines can be produced in very less time and storage is less of an issue because the seed is a stable form that will not degrade the nutritive part for long time. Our main goal through this chapter is to describe the nutraceuticals potential of grain and seed proteins to prevent and treat the disease with an easy and inexpensive way. In India, the week from 24 to 30 July is observed as Protein week to for awareness about the importance of protein in our diet. When the word protein comes to hear, usually muscle or meat comes in our mind but the farmers gold grains are also very important source of proteins. "National Nutrition Monitoring Bureau" Reported in 2017, that consumption of protein in urban Indians was below the recommended dietary allowance, they have taken only 89.8 percent of the recommended amount. In a vegetarian Indian diet, around half of your protein comes from cereals, so this gap could be spanned by including protein-rich diet daily. The comparative protein concentration in seed and grains enlightens the importance and uniqueness of cereals and legumes as nutritive dietary supplements as 3 ounce of chicken contains 20 g protein but 3 ounce of beef contains 21 g of protein, 1 egg contains 6 g of protein, 1 cup of black beans contain 15 g, 2 tablespoons of peanut butter contains 8 g Half a block of tofu contains 18 g protein [11, 24]. When cereals and pulses are combined they can expressively mend the quality of protein in your diet.

2. Applications of seed proteins

There are various types of seeds such as legumes, cereals, vegetables-fruit seeds and oilseeds which enlightens the era of health with vegetarian diet. Seeds are preferred over these systems because they store lots of protein in a relatively small volume and provide a stable environment that promotes protein assemblage and inhibits degradation, thus facilitating long-term storage [8, 11]. For example, antibodies accumulate at high levels in seeds and endure stable for several years with no loss of activity when preserved at room temperatures [12]. In practical terms, this means that cereal seeds containing pharmaceutical nutrients can be stored and disseminated in countries lacking a reliable cold chain. A relatively high protein concentration is achieved because most seeds are small and compact with a simple proteome, which also reduces the number of competing proteins released during processing. Proteins are crucial to all living organisms for function, structure, and regulation of the body. Formation of protein in a cell starts with DNA transcribing into RNA, and RNA translating into proteins. Amino acids (AA) make proteins and are arranged in different combinations and this arrangements and lengths of AA determine the function of the protein, e.g. hormones, enzymes, and antibodies. The given **Figure 1** shows the role of grain proteins in human body in energy production and precursors of other useful molecules.

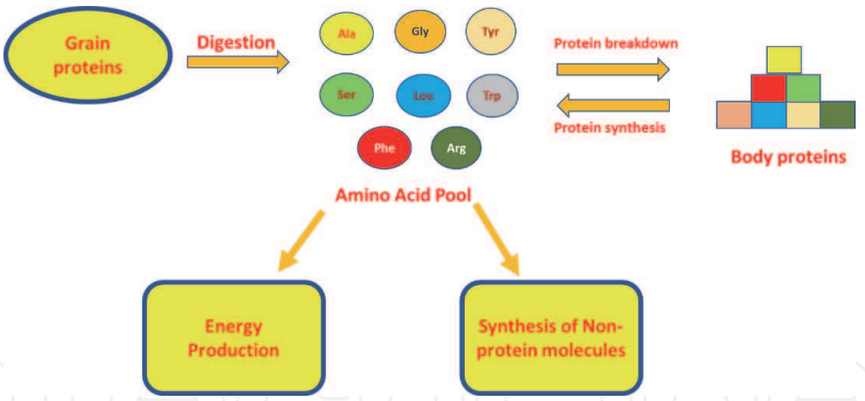


Figure 1.
Role of grain proteins in Human body.

2.1 Legume seeds

The nutritional composition of legume proteins makes it different and useful in food products. Berman et al. [13], in his book chapter focused on the health benefits of legume seeds as potential nutraceutical and also explained the prevention and treatment of certain diseases such as cardiac diseases, diabetes, gastrointestinal infections, obesity, cancer, skin related problems using legumes in diet. Legume seeds also contain resistant proteins that play an active role in human health [14]. Legume seeds contain enzyme inhibitors like alpha-amylase, alpha-glucosidase and gamma-aminobutyric acid (GABA) for which it can be used as a nutraceutical's molecule. Information on legumes grain, presented by FAO (1966), shows consumption to be high in many countries. The popularity of legumes is based on many factors, including their capacity to fix nitrogen to produce a grain containing a high level of protein of a quality which complements the inadequacies of cereal protein. All legume seed proteins are relatively low in sulphur-containing amino acids and tryptophan, but the amounts of another essential amino acid, lysine, are much greater than in cereal grains [15]. Legume seeds such as pea and beans contain 18–20% protein and lupin, soyabean contains 30–35% protein. Variable proteins in legumes shows antifungal, anti-viral, anti-HIV and anti-diabeteic properties, also these proteins are precursors of amino acids which are beneficial to human health [16]. The proteins present in *vigna species*, show anti-fungal and anti-viral activities. Ground beans lectin acts as hemagglutinating agent due to presence of polygalacturonic acid and also curative agent of Hepatoma (HepG2), Leukemia (L1210) and Leukemia (M1). Presence of all these special and beneficial properties makes them excellent drugs for the treatment of AIDS with no harmful effects as compare to synthetic drugs [17]. Beans, chickpeas, lentils, tofu and low-fat dairy products are also good sources of protein, as well as other health-enhancing nutrients like antioxidants and fibers (**Figure 2**).

2.2 Cereals

Grains and seeds, provide not only the major portion of the energy for human populations throughout the world, but also play an important role of nutritive and pharmaceutical carriers. These are filled with nutrients vitamins, proteins, minerals, fibers and essential trace elements which grow nutraceutical values and pharmaceutical applications. To increase the human health awareness, we must have to enlighten the importance of easily available seeds and grains in our food. The cereal grains like rice, wheat and corn are staple foods in several parts of the world.



Figure 2.
Legume Seeds.

Wheat is the key source of nutrition for many organisms and wheat proteins are one of the extremely used dietary proteins globally. Gliadins and glutenin are the foremost storage proteins of wheat and are deposited in distinct protein bodies in the starchy endosperm cells of the developing grain. The protein part of wheat accounts for up to 80% of the total grain nitrogen (**Figure 3**) [18].

Shewry and Tatham, in 1990 [19] reported the presence of prolamins in grains such as wheat, corn, rice and oats which are nutritious and healthy proteins to promote growth because the complete AA sequence of all major protein groups allowed for the redefine of their classification in relation to organizational and evolutionary relationships. The stored seed proteins are secreted and stored in separate protein bodies. However, the origins of the protein bodies and the mechanisms that regulate the transfer and transfer of proteins are still partially understood but the physical stability within the Golgi appears to be important, leading to the formation of electron dense clusters forming the contents of dense vesicles. The final protein Globulin contains understandable pro-domains that provide vacuolar targeting, but the inaccessible components within the sequence of mature proteins may be significant [20]. Oats are a hearty, gluten-free and inexpensive cereal.

Whitehead et al. [21] reported, much higher in protein in oats than other grains. A 1/2-cup (78-gram) serving provides 13 g of protein. Oats are high in vitamins and minerals, plus contain a type of soluble fiber called beta-glucan. Studies have shown that foods rich in beta-glucan may help reduce LDL and total cholesterol levels,



Figure 3.
Cereals.

making oatmeal a great choice for heart health. Choosing a bowl of oatmeal for breakfast is a great way to keep our heart healthy while increasing protein intake.

In maize seeds 10% proteins are there and out of these 10% nearly 70% of them are categorized as storage proteins [22]. Albumins, globulins, glutamines, and prolamins are four groups of proteins based on their solubility. The protein of maize grain varieties contains nearly two times lysine and tryptophan, AAs that are essential for humans and monogastric animals. These two AA allow the body to synthesize complete proteins, thereby eliminating wet-malnutrition, moreover Trp can be converted in the body to niacin, which is supposed to reduce the incidence of Pellagra.

Among cereals rice has lowest protein content (7%), bran layers and embryo are wealthier in non-starch constituent than the milled (white) rice. Protein from rice reduces both cholesterol and triacylglycerol levels in the liver, suppressing ability of fatty acid synthase, G6PD and MDH in liver and enhancing those of lipoprotein lipase and hepatic lipase [23]. Rice protein is also rich in Gln, Asn like other cereal proteins.

Major AAs present in Teff (*Eragrostis tef*) are Glu, Ala, Pro, Asp, Leu, Val, whereas Mat, Phe, His and Arg are essentially higher in Teff than other cereals, except rice and oats. The balance between essential AAs is similar to the whole edible portion of egg protein, except for its lower Lys content. The overall AA profile of Teff can be regarded as well balanced. Teff is different from other cereals in having higher albumins, globulins and its protein which is essentially free from gluten found in wheat so demand of Teff grain foods are increasing and become important for consumers who are allergic to gluten found in wheat [24].

Protein content of sorghum grain is quite variable, ranging from 7 to 16% with an average of 11% approximately. The key proteins are prolamin (storage proteins) as present in all other cereal grains, are called as 'Kafirins' [25]. On the basis of differences in MW, solubility, structure, AA composition and sequence, Kafirins are classified into four major species. Kafirins have low nutritional quality because they have very less quantity of essential AA, particularly lysine [26]. They are poorly digestible, especially when cooked in water, as occurs during most food preparation processes [27].

Nowadays, crops are turning into factories which don't produce food but also participating in the production of monoclonal antibodies, drugs, vaccines and enzymes. For the production of protein which are pharmaceutical active firstly we have to synthesize/isolate the genes that are responsible for pharmaceutical proteins and transformation of those genes into the desired crops then transfer of those genes into the DNA of desired crops. Different plant species, an animal (a human being) or a bacterium can be the sources of these genes or transgene which are to be transferred into the desired host. The genetically modified crops are then cultivated, harvested and pharmaceutical protein produced by crop is extracted, purified and modified prior it is given to humans or livestock [5, 6].

Cereals such as Rice (*Oryza sativa*), Wheat (*Triticum vulgare*) and Maize (*Zea mays*) are pharmaceutical crops and the major staple food consumed by half of the population globally. Rice seeds have recently gained attention as bioreactors in the production of human pharmaceuticals such as medicinal proteins or peptides. Rice seed production stages have beneficial over animal cell or microbe systems as it is more economic, scalable, safe and productive. Human pharmaceuticals based on rice seed are predictable to become inventive therapies as edible drugs. Therapeutic proteins can be divided into cellular components in rice seeds and secured to harsh areas of the stomach [28]. A high nutritive value of maize [29] bound up a valuable book chapter which explains the nutritive agents of macro and micro quantity and their

effective health benefits to protects diseases. Maize is a good source of B-complex vitamins along with antioxidants such as different types of polyphenols [30].

2.3 Vegetable and oilseeds

Oilseeds are rich source of protein and due to that these are high in demand in animal and human feed. In many of countries, the attention is on brassica crops, which comprises canola, rape and mustard. Oilseeds and their ingredients developed as resolute foods or as sources of nutraceuticals deliver benefits for consumers and diet processors. Sarwar et al. [31] reported a review article entitled "The role of oilseeds nutrition in human health: A critical review" in which the nutritional value of variable oilseeds was discussed and enlightens the nutraceutical potential of oilseeds. That article was focused on the key sorts of oilseeds, their role in human health and ailments, and high lightened the new progresses that may offer even more benefits in the future. Oilseed foods from soybean, peanut, rapeseed and flaxseed are rich in protein; when assorted with other components (cereal grains), and they deliver nutritionally balanced feedstuffs [32]. Mustard seeds and its oil have customarily been used to release muscular pain, rheumatism and arthritic pain. The mustard oil also very helpful in stimulating hair growth when applied over scalp also its ground seeds perform the role as a laxative, stimulant to gastric mucosa and surge intestinal secretion [33]. The Cucurbitaceae seeds such as *Cucumeropsis mannii*, *Cucurbita maxima*, *C. moschata*, *Lagenaria siceraria* and *Cucumis sativus* and their defatted cakes are rich in proteins hence these seeds can thus be measured as cores of proteins and oils (**Figure 4**) [34].

Oilseed rape is a very valuable crop as the seed is naturally 42% oil and the meal port after eliminating the oil is about 42% crude protein. Proteins serve a variety of functions in the human body such as acting as enzymes, antibodies, and the structural components of tissues, hormones and blood protein. The main function of dietary protein is to supply AA for the growth and maintenance of body tissue. Digestion disassembles proteins into their basic building blocks AA. Furthermore, the oil is particularly of high quality and high in monounsaturated, and should logically be a premium product. Today's certain varieties of oilseed rape have been bred to provide oil that is suitable for use in cooking and food processing. Known as vegetable oil, the oil is widely used by the food industry and is now being increasingly processed for use as bio-diesel [33].

Pumpkin seeds deliver a massive amount of nutrients in a very small package. Adding these budget-friendly seeds to your diet is a smart and healthy way to increase our protein consumption. Just 28 g of pumpkin seeds contains 7 g of



Figure 4.
Oilseeds.

protein, making them an exceptional choice for a protein-packed nosh. Along with a magnificent volume of protein, pumpkin seeds also contain antioxidants like vitamin E and phenolic acids that help reduce inflammation in the body. (www.nutrition).

Oilseed protein makes a significant influence to the human alimental protein ingestion. Furthermore, oilseeds are mostly richer in Sulphur AA than legumes, but minor in lysine except for rapeseed. The nourishing value of oilseed meals depends mainly on the oil extraction process. International dietary guidelines commend the intake for their contribution of proteins, and especially of mono and polyunsaturated fatty acids as lessens the risk of chronic diseases. Back, [35] reported that G-proteins present in the oilseeds, plays a significant role in the synthesis of Omega-3-fatty acids which supports to reduced risk of cardiovascular disease and Atherosclerosis (hardening of the arteries). There are a long list of oilseed and protein present (**Table 1**), these proteins are very beneficial to human and animal health.

2.4 Summary points

- Grain and seed proteins are easily available and economic food to obtain the valuable dietary supplement protein for every person.
- Grain protein concentration, usually stated in percent of grain dry mass.
- Proteins act as a buffer system, helps our body to maintain pH values of the blood and other body fluids.
- Proteins forms antibodies to protect our body against foreign invaders.
- The recommended protein intake for an adult is usually based on body size: 0.8 grams per kilogram of body weight.
- Variations in grain protein concentration induced by weather, water and nitrogen availability, especially during the grain-filling period.
- In oilseeds, an upsurge in oil concentration is usually associated with a decrease in protein concentration.

S.No.	Oil seed Species	Major Storage Protein
1	Canola (*Brassica* species)	Cruciferin
2	Corn (*Zea mays* L.)	Zein
3	Cottonseed (*Gossypium* species)	11S protein
4	Flax (*Linum usitatissimum* L.)	12S protein
5	Hemp (*Cannabis sativa* L.)	12S protein
6	Peanut (*Arachis hypogaea* L.)	Arachin
7	Safflower *(Carthamus tinctorius* L.)	Carmin
8	Sesame (*Sesamum indicum)*	α-globulin
9	Soybean (*Glycine max)*	Glycinin
10	Sunflower (*Helianthus annuus)*	Helianthin

Table 1.
Oil-producing crops and the major storage proteins suitable for human consumption.

- Cereal proteins are less digestible by children and adults than egg and milk protein, except for wheat endosperm.

3. Conclusion

The nutraceutical values of seeds for human health need to be needed zones of recent research. Promised research should focus on probable effects of bewildering factors that may be correlated with the use of nutritive and medicinal values of seeds. This is for above cited data suggest that seeds have valuable applications in the inhibition and treatment of numerous human diseases. Hence, it is imperative to explore not only bioavailability and chemical composition of seeds but also to characterize biological possessions to determine the mechanism as well as their synergistic assets to ensure the nutrition values for human health and make ready to overcome from pandemic and steady diseases in future.

Abbreviations

3-letter abbreviation	Amino acid
Ala	Alanine
Arg	Arginine
Asn	Asparagine
Asp	Aspartic acid
Glu	Glutamic acid
Gln	Glutamine
Gly	Glycine
His	Histidine
Leu	Leucine
Lys	Lysine
Met	Methionine
Phe	Phenylalanine
Pro	Proline
Ser	Serine
Thr	Threonine
Trp	Tryptophan
Tyr	Tyrosine
Val	Valine
AA	Amino acid
G6PD	Glucose 6-phosphate dehydrogenase
MDH	Malate dehydrogenase

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