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Review Article

Nutritional Importance and Bioavailability of Plant Proteins in Human System

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Abstract

Protein is an essential nutrient which is required by human body to grow, tissue building, repair cells, and to work properly. A 'complete' protein has all the nine essential amino acids necessary for dietary needs. Animal proteins like chicken, fish or dairy products have all of the essential amino acids and are known as 'complete' protein (or ideal or high-quality protein). The awareness about food security and the challenge of an ever-growing world population encourage the search for sustainable and environmentally feasible high-nutritional foods, including the exploration of alternative protein sources. It goes toward replacing traditional animal proteins by alternative ones, requiring developing techniques to evaluate and increase their digestibility and bioavailability. The nutritional value of a protein is related to the bioavailability of its constitutive amino acids and depends on the efficiency of their metabolic utilization to meet the amino acid requirements necessary for growth and body protein turnover. To achieve sufficient quantities of certain essential amino acids plant based diets, mainly vegan, must be varied and include portions of different foods to adequate quantities of limiting amino acids. Eating a range of different plant-based proteins across the day will provide a complete amino acid profile to human body as they don't have complete amino acid sequence.

Keywords: *Amino acids, Plant based proteins, Digestibility, PDCASS.*

Introduction

The nutritional value of a protein is related to the bioavailability of its constitutive amino acids and depends on the efficiency of their metabolic utilization to meet the amino acid requirements necessary for growth and body protein turnover. Protein is an essential nutrient which is required by human body to grow, tissue building, repair cells, and to work properly. It is found in different types of food. How much protein one person need varies depending on their weight, gender, age and health? Protein is made up of smaller building blocks called amino acids. There are 20 amino acids which link together in different combinations and these are of two types: a. 11 non-essentials (can be made by the body) and b. 09 essential (must be obtained through the diet). A 'complete' protein has all the nine essential amino acids necessary for dietary needs. Most plant based foods, however, are not complete proteins as they only have some of the nine essential amino acids.

Animal proteins like chicken, fish or dairy products have all of the essential amino acids and are known as 'complete' protein (or ideal or high-quality protein). Whereas plant proteins like beans, lentils, nuts (**Figure 1**) usually lack at least one of the essential amino acids and are considered 'incomplete' proteins except soy products, quinoa which also has all of essential amino acids. The awareness about food security and the challenge of an ever-growing world population encourage the search for sustainable and environmentally feasible high-nutritional foods, including the exploration of alternative protein sources. Organizations like **Ayurvet Research**

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Foundation (ARF) and Quality Certified and Standardized (QCS) Herbals Pvt. Ltd. working for sustainable have research interest in the areas of 5 F (Food, Feed, Fertilizer, Fodder and fuel) and quality assurance of medicinal plants. Isolation of protein from plants, agriculture waste or by products is one of their main research objectives.

Replacing traditional animal proteins by alternative ones, requiring developing techniques to evaluate and increase their digestibility and bioavailability. Food protein quality as assessed by digestibility, net protein utilization, and biological value has so far been better for animal-based protein than plant based proteins.

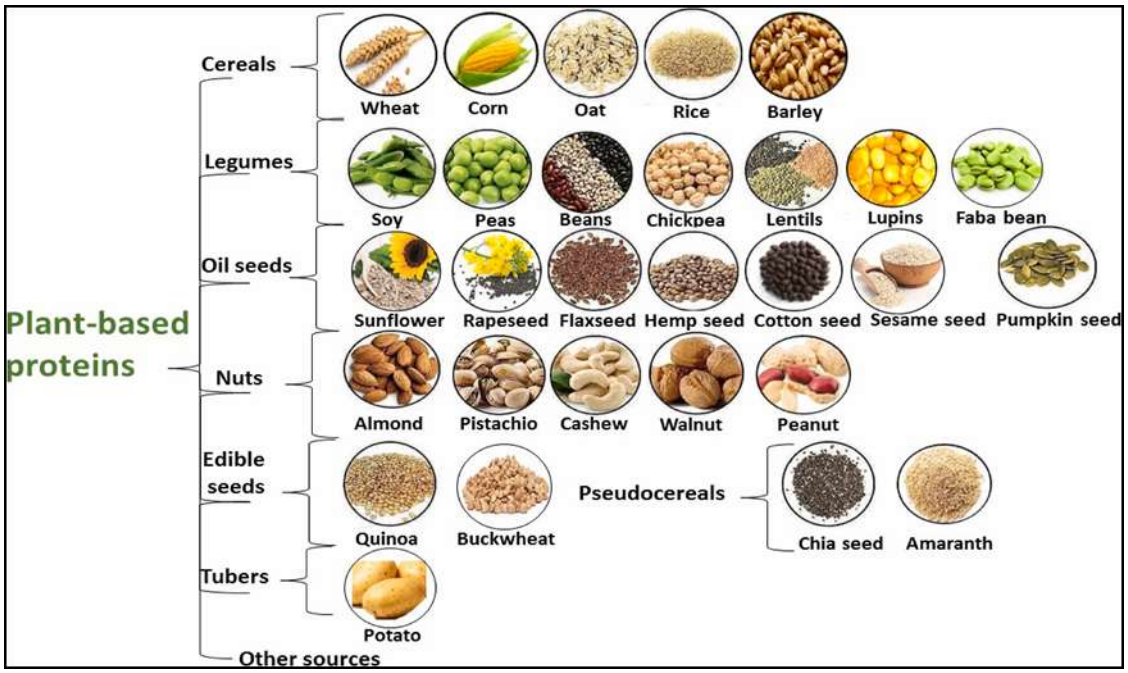

Fig 1: Different sources of Plant based proteins [Nasrabadi, M.N]

Claimed Health Benefits of Plant Based Proteins:

1. Plant based diet is associated in significant reductions in blood pressure.
2. According to studies, people eating vegetarian diets tends to have lower cholesterol levels, and lower risk of stroke, cancer, and death from heart disease than people who eat meat [healthline.com].
3. Fiber present in plant based proteins helps regulate the body's sugar use, keeps hunger and blood sugar in check, and helps food move through the digestive system with regularity **[**uclahealth.org**]**.
4. Phytochemicals found in beans and legumes are considerably beneficial in improving blood cholesterol levels, glycemic status, providing vascular protection, and reducing markers of chronic inflammation, also effective in the prevention and modulation of obesity-related chronic diseases including CVD and T2D.
5. Plant-based dietary approaches that support optimal nutrient intake, healthy body weight, and reduced inflammatory status may be an effective protective force against immune-related diseases [Mullins, A.P. *et al*., 2021].

The Protein Digestibility Corrected Amino Acid Score (PDCAAS) is a composite indicator of protein quality used to assess the ability of dietary protein to meet the body's amino acid requirements. If PDCAAS of any protein is less than 100%, it means this cannot fully meet the body's essential amino acid requirements and all plant-based protein sources that have been tested to date are characterized by a PDCAAS that is below 100% except soya protein isolates for example wheat gluten is the plant-based protein with the lowest PDCAAS value at just 25%. PDCAAS of plant-based protein sources are lower due to their lower digestibility

compared to animal-based proteins and/or to a deficiency in certain essential amino acids for body needs. FAO proposed a protein quality score named the Digestible Indispensable Amino Acid Score (DIAAS), which takes into account the digestible amino acid content compared to a reference protein and its ileal digestibility.

PDCAAS and DIAAS indexes give an indication of the first limiting amino acid of the protein. Sulphur amino acids are the first limiting amino acids in legumes, such as soybeans, peas, faba beans and lentils whereas in cereals, such as wheat and maize, lysine is the first limiting amino acid. Consequently, the low essential amino acid content could limit protein synthesis. This means that amino acid composition, protein digestibility, and availability are the determining factors for assessing dietary protein quality. Eating a range of different plant-based proteins across the day will provide a complete amino acid profile to human body as they don't have complete amino acid sequence [betterhealth.vic.gov.au; betterhealth.vic.gov.au; Berrazaga, I. *et al*., 2019; foodunfolded.com; Sá, A.G.A. *et al*., 2020]. Major drawback of consuming plant-based diet is lower digestibility of plant proteins, in addition to the foods of plant origin. Researchers are attracted towards replacement of animal protein with alternatives like plant proteins due to growing livestock contribution to greenhouse gas emission, food safety reasons, etc. Foods of plant origin (Green Protein) are significant sources of anti-oxidative vitamins, minerals, unsaturated fats, complex carbohydrates, non-essential amino acids, and are unique or principal sources of vitamin C, folate, fibre and various non-nutrients. Advantages of Plant proteins: Maintenance of healthy & balanced lifestyle, improves sustainability i.e. lower green house gas emission, decreased risk of chronic non communicable diseases (NCDs), such as diabetes, ischemic heart disease, and cancer, etc. [Sharma, K. *et al*., 2022; Nichele, S. *et al*., 2022].

To achieve sufficient quantities of certain essential amino acids plant based diets, mainly vegan, must be varied and include portions of different foods to adequate quantities of limiting amino acids. For example, legumes have low amounts of sulphur amino acids, such as cysteine and methionine, but they have higher amounts of lysine when compared to cereals. Cereals, in turn, offer sufficient amounts of sulphur amino acids, complementing the amino acid limitation of legumes. Indeed ecological validation of the need to compliment legume and grain-based proteins, likely due to biological stressors (i.e., disease, famine, or the ability of children to thrive), can be seen in common legume– grain pairings in globally diverse geographic regions. Thus, co-consumption of legumes and grains would deliver adequate quantities of essential amino acids to support requirements [Nichele, S. *et al*., 2022].

Plant proteins are also usually harder to digest than animal proteins. The fibers and other components in plants make it harder for digestive enzymes to break down proteins for absorption in our digestive tract. The good thing is that this same trait of plants can be beneficial when it comes to things like heart health or blood sugar management, due to limiting the absorption of carbohydrates or cholesterol. Processing via soaking, cooking, concentration, or isolation can also make plant proteins easier to digest [khni.kerry.com].

Protein Digestion and Absorption: In general, the digestibility of protein source has been defined as the proportion of dietary protein–derived AAs that is effectively digested and absorbed, thus becoming available in a form suitable for body protein synthesis. Animal-based protein sources, including dairy, eggs, and meat, are highly digestible (>90%). In addition to digestibility issues, it was reported that the dietary protein–derived AAs from the plant-based proteins soy and wheat are more readily converted to urea when compared with the ingestion of milk proteins. This would ultimately lower the potential of these plant-

based protein sources to stimulate the skeletal muscle anabolic response. The exact reason(s) why the ingestion of these plant-based proteins leads to greater urea synthesis is not fully understood but may relate to the relative lack of specific EAAs as same cannot be synthesized in the human body and therefore have to be supplied through the diet.

Depending on the processing method and/or the presence of various ''antinutritional'' factors like presence of saponins, tannins, phytic acid, gossypol, lectins, protease inhibitors, amylase inhibitor, and goitrogens in edible crops (i.e., compounds in the food source that interfere with digestion and absorption of the available protein), plant-based sources such as maize, oat, bean, pea, and potato tend to exhibit lower digestibility than do animal-based sources, with values ranging from 45% to 80%. However, once freed from these antinutritional factors using methods and technologies like extrusion, roasting etc., purified plant protein sources such as soy protein isolate, pea protein concentrate, and wheat gluten display a digestibility that is similar to that of animal-based protein sources [van Vliet, S. *et al*., 2015; Samtiya, M. *et al*., 2020; justagric.com].

Conclusion

Plant proteins are usually harder to digest than animal proteins. The fibers and other components in plants make it harder for digestive enzymes to break down proteins for absorption in our digestive tract. The good thing is that this same trait of plants can be beneficial when it comes to things like heart health or blood sugar management, due to limiting the absorption of carbohydrates or cholesterol. Depending on the processing method and/or the presence of various ''antinutritional'' factors like presence of saponins, tannins, phytic acid, gossypol, lectins, protease inhibitors, amylase inhibitor, and goitrogens, plant-based sources tend to exhibit lower digestibility than do animal-based sources. However, once freed from these antinutritional factors using methods and technologies like extrusion, roasting etc., purified plant protein sources such as soy protein isolate, pea protein concentrate, and wheat gluten display a digestibility that is similar to that of animal-based protein sources.

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