Sustaining Protein Nutrition Through Plant Based Foods

*Dr. Anupama Johri
**Dr. Sulochana Sharma

Abstract

Plants and animals both provide protein sources. When thinking about the effects on human health, eating animal proteins should be avoided in favour of plant-based alternatives. Plant-based proteins are more budget-friendly than their animal-based counterparts. One of the numerous factors that determines the quality of proteins is their biological value. More of a certain essential amino acid makes a protein more valuable from a biological standpoint. For this reason, eating a wide variety of plant-based foods is recommended, since each is poor in some essential amino acid. Plant-based proteins are less appetising on their own, thus they must be flavoured to increase their appeal. The quality and quantity of isolated proteins may be drastically altered by the techniques used for isolation and purification. Protein structures are typically determined using techniques such as X-ray crystallography, spectroscopy, and nuclear magnetic resonance. In addition to structural analysis, amino acid sequencing by mass spectrometry may provide insight on a protein's function. Ultrasonic assisted extraction, enzyme assisted protein extraction, and the electro activation approach are just a few of the methods that may be used to separate and purify these proteins. The availability of plant-based proteins has enabled their use in several industrial applications, such as dairy substitutes, fake meats, and bioactive peptides, all of which are briefly discussed in this review.

Keywords: Pseudo cereals, legumes, plant proteins, and vital amino acids all have high biological value.

INTRODUCTION

Increased demands on essentials like water and food are inevitable in the face of a growing human population. In this context, meeting dietary needs involves consuming not just enough calories but also the right types of macronutrients. Proteins are crucial to human health, yet producing them at a large enough scale presents significant challenges. Highly valued as they are, proteins derived from animals are in short supply and have challenges meeting rising demand. As a result, [1][2] finding a reliable alternate protein source is crucial. There are 20 amino acids in the human body, none of which are required for survival. Plant-based proteins are an option since they are easy to farm, cheap to produce, and kind to the environment. In contrast to necessary amino acids, which can only be obtained via food, excess amino acids may be synthesised internally. The nutritional value of a protein increases with factors such as its amino acid concentration, availability, purity, digestibility, an-nutritional component (drugs that, when present, modify the accessibility of proteins either by themselves or by certain meta-bolic processes), etc. Increasing meat consumption is associated with problems like resource depletion, extinction of species, climate change, water scarcity, etc [3]. There has so been a recent trend towards using plant-based proteins. On the other hand, there are proteins that are lacking one or more of the nine necessary amino acids. In order to make the transition from plant proteins to animal proteins, several obstacles had to be overcome. Quality and amount of proteins must be monitored and ensured at all stages of production. The manufacturing and materials stages should not cost too much money. The flavour of tree protein meals may be enhanced using seasonings. It must be simple and easy to understand. In this respect, typically pro and allergies may restrict nutrient intake (4). Vegans and vegetarians should eat a wide range of beans, grains, seeds, nuts, fruit, and vegetables to meet their protein needs. Lean protein sources are great alternatives since they are low in cholesterol and saturated fats. As the global population rises, the need for animal protein decreases; thus, it is critical that we find ways to replace them with plant-based alternatives.

Protein Structure and Functionality

Proteins, which are macromolecules composed of linear polymers of amino acid residues held together by peptide bonds [3], are useful in food formulations because of their structural, functional, and nutritional qualities. In functional proteomics, protein structural analysis is step one. Whereas understanding the three-dimensional protein structure might help researchers better understand structural-functional links in biology, intramolecular and intermolecular structural changes that occur during food processing only provide a partial picture of protein's involvement in food. [4] Treatments like high pressure have been used to affect the structural and functional features of proteins since changes in secondary and tertiary structure are often associated to modifications to protein function (heat denaturation for gelation; unfolding at an interface). To react with carbonyl molecules, such those present in food, the amino acid lysine needs a positive charge on its surface and the nucleophilic capabilities offered by the e-amino ring on its molecule. Changing the charge of a protein or creating a conjugated molecule by adding a sugar or oligosaccharide at the start of the Maillard process are the two most prevalent methods [7-8]. The most prevalent technique involves altering a protein's charge. When a protein is deamidated, its charge and isoelectric point may be shifted [8, 9].

Inherent features of proteins include hydrophobicity, charge distribution, and the existence of reactive groups. The nature, quantity, arrangement, orientation, or interactions of the protein's amino acids all play a role in defining its characteristics [10]. Protein solubility, gelation, thermal stability, and emulsification are all functional features that may be modified by changing the protein's structure, molecular weight, physicochemical properties, and processing conditions. One example of a functional property is an increase in the protein's interactions with other molecules, which facilitates its handling, storage, and degradation. [11, 12]. Plant-based meals and components need a plant protein with strong functional capabilities and the ability to mimic the performance of animal proteins. One of the most basic approaches to learning about protein's role in a food system is to examine isolated protein solutions or dispersions. - Researchers have looked at lactoglobulin more than any other useful dietary protein. An all-encompassing model for conformational changes and aggregation between 20 and 150 degrees Celsius was recently provided by a research [13]. Conversely, protein components are often not only proteins (such those found in whey or egg white proteins), instead being a complex mixture of proteins and many other macromolecules, such as carbs and minerals.

For a formulation to "work," as opposed to just being a collection of parts, it is essential that all of the proteins involved "act" as they should. Finding ways to alter or restructure plant proteins such that they retain the same functional qualities as animal proteins is one of the most pressing concerns in the study of plant-based proteins. There are three main classes of proteins, which generally correspond to the three most prevalent forms of tertiary structures found in proteins. You may categorise proteins as either globular, fibrous, or flexible. Typically enzymes, soluble versions of globular proteins are more unusual. Proteins like collagen and keratin, which are found mostly in connective tissue and hair and nails, respectively, are examples of fibrous proteins with structural features. Hair and keratin may be found in nails, as can collagen. Fibrous-structure proteins are notoriously difficult to dissolve in aqueous and other solvents like acids and bases [14]. Conversely, typical globular proteins may disintegrate easily under these conditions.

Some examples of plant globular proteins include protein (which is soluble in water), globulin (which is soluble in dilute salt solutions), prolamin (which is soluble in aqueous alcohol), and glutelin (which is insoluble in water but soluble in dilute acid or alkali). More than 85% of the protein content in cereals [17] and in the faux cereal family [14, 18] is found in the prolamins and glutelins that are present in wheat, maize, barley, and rye. In contrast, all pulse (>50%) [16] and certain pseudo cereals (50%) are composed mostly of albumin and globulins (quinoa, and amaranth). Collagen triple helices are the building blocks of connective tissue, which is composed of a complex network of fibrous protein bundles composed of sarcoplasmic, stromal (elastin, collagen), and myofibrillar (actin, myosin, tropomyosin, troponins) proteins [19,20]. Last but not least, proteins that form filaments are exceptional in that their structures are fluid and chaotic. Casein is not a uniform molecule; rather, it is shaped like a random coil [21]. It also has both hydrophobic and hydrophilic sections. Casein's ability to form micelles is facilitated by its molecular structure, specifically its interactions with calcium and phosphate molecules [22, 23]. The randomized coils of hydrophobic, hydrophilic, and phosphate groups in casein, together with the protein's high prolyl content that enables it to adopt open and flexible conformations, all contribute to the protein's high activity [22]. Proteins may also stabilise surfaces by binding to them. Due to the absence of elastic spontaneous shapes or micellar structures in the vast majority of known natural plant proteins, it is challenging to duplicate the structural and physicochemical properties of gelatin and casein proteins. Our results emphasise the need of doing more studies into the building of protein sources into edifices that may share features with animal proteins. Adding random coils to the structure of globular protein sources or assembling a group of protein sources into micelles with a casein-like form are two possible mechanisms for accomplishing this goal.

Plant-Based Proteins: Definition and Types

The advantages of a plant-based diet have gained considerable attention in recent years. Consuming more plant-based meals is one way to cut down on calories without sacrificing nutrients. Protein isolated from plants is called plant protein, and it serves as a useful dietary source. Pulses, soy tofu, tempeh, seitan, nuts, seeds, and certain grains and peas are all part of this category. Proteins from plants, especially globulins, have historically been extracted from the seed coats of cereal grains and legumes. Plant proteins may be divided into the following categories based on where they're derived:-

- TVP (textured vegetable protein) found in soy products such tempeh, tofu, edamame, soy milk, and soy crumbles..
- Lentils, beans, grains, chickpeas, black beans, and other legumes and beans, as well as a vegan eggs.
- Products made from peas, such as pea protein powder and pea protein milk
- Foods made from grains like seitan, whole wheat flour, spelt, and teff.
- Those derived from nuts and seeds, such as almonds, cashews, pistachios, chia seeds, flax seeds, and rapeseeds
- Potatoes, sweet potatoes, broccoli, and asparagus are all examples of vegetables.
- Others: Mycoprotein, algae

Biological value

Protein quality may be evaluated in part by measuring its biological relevance. Whether or whether a protein is biologically useful depends on how much of its constituent amino acids are provided by the diet (9). To determine a protein's biological significance, scientists look at how many of its amino acids can be metabolised by the body (10). High biological value proteins contain an abundance of all the essential amino acids, whereas low biological value proteins are missing some of these amino acids [15][16].

Major plant protein sources

Legumes

Legumes are members of the family Leguminosae. Because of their high protein content and the other nutrients (minerals, vitamins, and calories) they provide, they are an essential element of the human diet. Legume is sometimes called "poor man's meat" because of its substantial protein content and low price [17,18]. Pulses, which are from the legume family and are a great source of protein, play a huge role in both the African and Asian diets. Pulses include many common foods such as beans, peas, pigeon peas, chickpeas, peanuts (ground nuts), faba beans, soybeans, lentils, mung, mung beans, cowpeas, black gramme, and kidney beans [19].

Soy proteins

Soybeans are cultivated as a food staple and a source of oil, despite being a kind of legume. Among grains and legumes, soy beans' protein content, at 34% to 37%, is the greatest. Also included are carbs and fibre. Soybeans are processed further before they may be used to make foods for human consumption, such as soy milk for children, soy flour, soy concentrates, tofu, and soy isolates. Storage proteins in soy, such as glycinin and -conglycinin, provide a good source of protein overall, although they are deficient in sulfur-containing amino acids like cysteine and methionine. Minor proteins including lectins, lipooxygenase, and others are eliminated since they may compromise the food's nutritional value and alter the way it tastes [20].

Lentils

The Leguminosae family is responsible for the domestication of a wide variety of legumes. Its structure is so similar to a lens that it earned them the title. These days, consumers may choose from a vast array of lentil varieties. Popular pulses include many different types of beans, such as the green gramme bean, red lentil, yellow pigeon pea, green and white pea, bengal gramme, black gramme, etc. Lentils are a good source of the sulfur-containing amino acids cysteine and methionine, but they are deficient in the important amino acids phenylalanine, leucine, threonine, and lysine. There is a possibility that lentils include traces of minerals like iron, potassium, phosphorus, zinc, and so on. Vitamin B is also abundant in these foods. Lentils and grains together provide a protein source [21]. Cereals Cereals, sometimes referred to as grains, are the edible seed of plants in the grass family Gramineae. Cereals are a vital part of a healthy diet because of the many essential nutrients they provide, including carbohydrates, protein, vitamins, and minerals. Large-scale cereal crops include wheat, barley, maize, rice, oats, and many more. Rice is an essential component of cuisine in many regions of the world.

Isolation and purification of plant based proteins

Neither the amino acid sequence nor the three-dimensional structure of a protein can be interpreted independently of its function. Many methods, including as X-ray crystallography, spectroscopy, and nuclear magnetic resonance (NMR), may be used to determine the three-dimensional protein structure. Having a firm grasp of a protein's three-dimensional structure is crucial, but so is understanding its amino acid sequence. Peptide and protein sequencing, protein conformation studies, and protein dynamics are all examples of mass spectrometry applications that depend on molecule separation based on their mass to charge ratio [22]. The next step is to decide on a specific sequence of amino acids. Isolation and purification from the proper source is possible if identifying features like structure and amino acid sequence are known. In order to isolate, measure, and purify a protein, it may be subjected to any number of processes, the choice of which depends on its unique physical characteristics. Whether or not a given protein source or type is appropriate for isolation depends on their chemical, physical, and biological characteristics [23]. Optimal outcomes depend on the precise regulation of several process parameters [24]. After proteins are separated, the next step is purification, which gets rid of any remaining contaminants. Ultrafiltration, dialysis, mi-cellar precipitation techniques, and isoelectric precipita-tion are only some of the protein purification methods available. These methods are often employed for protein ex-traction, although the resulting material is a combination of protein and non-protein components. Several methods, including ultrasound-assisted extraction, are addressed for isolating the pure protein from the remainder of the recovered material [25]. The pace of progress in the food sector has been significantly impacted by this method. [26][27].

Challenges of Incorporating Plant Proteins in Foods

The idea that one's health and wellbeing might benefit others is not new. But days, shoppers everywhere—from India to the United States—expect brands they support to use only safe, non-GMO ingredients. Significant scientific and economic improvements in the area of plant-based proteins have been made in response to the rising popularity and universal acceptance of plant-based diets. To do this, we need to develop more effective fractionation strategies and methodologies, as well as find new, sustainable protein extraction techniques. Food scientists are working to perfect methods for cultivating plant-based protein sources, enhance their dietary profile, and decipher their technological functioning in foods. Yet, there are a number of technological and financial hurdles that must be overcome by the food and beverage industry to successfully include plant proteins into a high-quality product, especially for those that rely largely on animal-based components. These include things like:

- Plant-based proteins are more challenging to isolate and purify than animal-based proteins. This is due in part to the unique structural properties of plant proteins and in part to the fact that proteins are often found in the plant matrix in a physiologically complexed state with other macromolecules.
- Poorly balanced amino composition, pro factors, and allergens provide nutritional problems due to the low protein content, poor quality, and digestibility of plant proteins.
- Plant-based protein components are functionally inferior to their animal-based counterparts, limiting the scope of product creation. These flaws include low water and fat binding characteristics, insufficient bioactivity (such as antioxidant and antibacterial qualities), and low emulsifying, gelling, and texturizing capacities. This is a huge setback since these functional features improve the taste, texture, and stability of a meal.
- Difficulties posed by plant-based protein sources, such as unpleasant flavour, colour, and texture.
- Increased manufacturing and material costs reduce profits..
- Issues with regulation and a lack of brand recognition among consumers.

Demand of Dietary Protein

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Functional Properties of Plant-Based Proteins

In addition, functional foods that are derived from plants have advanced. Several investigations have focused on soy protein's potential to reduce cardiovascular disease risk factors such inflammatory and immunologic dysregulation as a result of its functional analysis and bioactive characteristics. The bioactive characteristics of several different plant-based protein sources, including rice, lentils, fava beans, peas, lupin, hemp, and oats, have recently been studied in depth.

The effects of plant-based proteins on insulin, blood sugar, and hunger-controlling hormones have been the focus of several clinical research examining their health advantages. The findings of this research were inconclusive, despite its aim to show that plant proteins aid in maintaining constant blood sugar levels after meals. Many bioactive plant components, including flavonoids and carotenoids, have indeed been demonstrated to have beneficial impacts on human health. Plant proteins are multifunctional because they serve as both a nutrient source and a biological catalyst. They play a crucial role in the making of high-protein, gluten-free meals.

Protein's chemical and physical qualities make it useful for the processes of food preservation, digestion, extraction, and cooking. As proteins interact with other molecules such water, volatiles, salts, carbohydrates, lipids, and proteins, they change in solubility, foam ability, uptake capacity for water or fat, foam stability, gel-forming, and emulsifying activity.The molecular size, charge density, and protein structure of peptides and proteins contribute to their functional features. Moreover, radical reforms to proteins which occur during food preparation may influence the functional capacity of plant proteins, depending on the circumstances in which the processing happens. Isolates, concentrates, and protein flours are all viable protein sources that may be used in food formulation to boost the nutrient density and, by extension, the health benefits of the final product. Nonetheless, many different types of plant-based proteins were included in mass-produced foods because of their useful properties. Proteins' many advantages allow for the creation and stabilisation of emulsions of fats in foods like pasta, cakes, sausages, and soups; their solubility in beverages leads to solvation; their absorption and binding of water molecules traps water in these and other foods; the uptake of fat is associated with the binding of freed fat in these and other foods; and so on.

CONCLUSION

The goals of this analysis were to provide a road map to speed up the advancement of plant - based protein technology and science, with a particular emphasis on the growth of plant protein ingredients and the development of tasty and healthy plant-based future foods. Extraction, separation, and modification of plant proteins are fields with room for development. Further study is required to better understand the interactions between plant proteins and polysaccharides, to create new structuring methods, to include tastes provided by plant proteins, and to enhance the nutritional value of plant proteins. Further research is needed to determine the effect of various fractionation methods and enhanced functioning on it's own nutritional quality. Although plant proteins have been the primary area of investigation, it is important to remember that humans typically consume complete meals rather than individual nutrients when planning for the future of food.

***Associate Professor**
Department of Home Science
Govt. Girl's College Chomu, Jaipur
****Associate Professor**
Department of Zoology
LBS Govt. College, Kotputli Jaipur, (Raj.)

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