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Study on Plant Based Proteins

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***Abstract -**As the demand for more sustainable food options increases, understanding the nutritional value of plant proteins is important for both consumers and health professionals. Concerns about environmental and health impact continue to grow. plant proteins offer a viable solution with benefits ranging from low carbon emissions to reduced saturated fat. This overview covers a variety of plant-based protein options and describes their key nutrient and amino acid profiles. The present study includes a variety of plant-based protein sources, like soy, pseudocereals, legumes, and nuts. The study also explores the importance of plant based protein sources as a sustainable and nutritious alternative to traditional animal-based proteins. Plant proteins plays important role in supporting overall health, muscle development and weight management. Choosing plant protein over animal protein will not only improve your personal health, but also the health of the environment. Also plant protein have the potential to boost the functional property of food in which it is incorporated. By choosing a variety of plants, individuals have the opportunity to reduce greenhouse gas emissions, conserve resources, and promote an ethical and compassionate approach to food consumption. Current study concludes that plant proteins are good source of protein, may improve the human health, useful in reducing environmental degradation and helpful in developing the functional properties of foods.*

Key words -Plant, Protein, Health, Environment, Functional properties

I. INTRODUCTION

Since the beginning of life, plants have been utilized for human benefits, providing food, therapeutics, wood, fibers, and many others. Moreover, incorporating more plant-based proteins into one's diet can support sustainable food choices, as they generally have a lower environmental impact than animal proteins in terms of land use, water consumption, and greenhouse gas emissions [1].

Overall, plant proteins play a vital role in balanced and sustainable dietary patterns, offering both health benefits and environmental advantages. To provide an overview of plant-based protein that helps sustain a better life for humans and the nutritional quality of plant proteins, this review mainly focuses on the current state of using plants to produce proteins for human health. It mainly focuses on various sources and their alternatives with high-quality protein, factors affecting the nutritional value of plant-based protein, bioactivity and functionality, and its modifications [2].

II. PROTEIN

Proteins are essential macronutrients found in various tissues, including muscle, bone, skin, and hair. They enable movement, carry oxygen, and make up enzymes. Proteins are made up of 20 amino acid building blocks, with nine essential and nine insufficient. Complete proteins contain all nine amino acids, while incomplete proteins lack one or more. Plant-based proteins, such as grains, beans, nuts, seeds, and soy, are rich in protein. Protein quality is crucial for metabolism and tissue growth [3].

Protein Quality

Protein quality is a measure of how well a protein source meets the body's requirements for essential amino acids

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and overall nutritional needs. Several parameters are used to assess the quality of a protein source, including:

1. Protein Efficiency Ratio (PER)
2. Biological Value (BV)
3. Net Protein Utilization (NPU)
4. Chemical Score
5. Protein Digestibility Corrected Amino Acid Score (PDCAAS): This measures the protein quality based on the essential amino acid requirements of humans and the digestibility of the protein source. It is calculated by multiplying the amino acid score of the protein source by its digestibility. The amino acid score is the ratio of the amount of each essential amino acid in the protein source to the amount required by humans. The PDCAAS can range from 0 to 1, with 1 being the highest possible score. This parameter is considered the most accurate and reliable measure of protein quality for humans [4].

III. PROTEIN SOURCES

Table 1- Protein% of various plant based proteins

Sources	Protein %
Soybean	32-34
Buckwheat	8.5-18.5
Amaranth	12-16
Quinoa	12-18.6
Green peas	24.2-27.5
Chickpeas	19-25
Kidney beans	8.86-21.25
Black beans	8.86-21.25
Peanuts	25
Almond	13
Cashew	15.3-21.2
Walnut	26

(Source: Gupta, 2018) [5]

1. Soyabean

Although soya beans are perhaps the most important legume crop worldwide, there are still problems relating to their nutritional value including deficiency of sulphur-containing and other amino acids. Enhanced nutritional quality of soya beans, achieved through increasing the concentration of nutritionally essential amino acids, improves their nutritional value and would further enhance their role as a key raw material for inclusion into diets for non-ruminants.

Soy protein, derived from soybeans, offers numerous health benefits and is widely recognized as a valuable component of a balanced diet. Firstly, soy protein is a complete protein, containing all nine essential amino acids necessary for human health. This makes it an excellent alternative for individuals following plant-based diets or those seeking to reduce their intake of animal products. Research suggests that regular consumption of soy protein may help lower LDL (bad) cholesterol levels, thus reducing the risk of heart disease.These compounds may help protect cells from damage caused by free radicals, potentially reducing the risk of certain chronic diseases, such as cancer.

Overall, soy protein offers an array of health benefits and versatility, making it a valuable addition to a nutritious and balanced eating plan.

2. Pseudo-Cereals

Pseudocereals, including amaranth, buckwheat, quinoa, chia, wattle seed, and album, can be used in novel food applications like gluten-intolerant food, animal-based protein replacements, and packaging materials. Their protein content ranges from 10- 20%, and their nutritional quality is high compared to cereals and legumes. Processing technologies for these proteins have been developed for their effective utilization in food products and ingredients [6].

i. Buckwheat

Buckwheat, chia seeds, and quinoa seeds all have high protein quality, with buckwheat having a biological value above 90% due to its high concentration of essential amino acids and sulphur-containing amino acids, while chia seeds have a higher percentage of these amino acid [7].

ii. Amaranth

Amaranth proteins contain important amino acids varying by plant species and cultivar. They have a lower amino acid profile than cereals and legumes, with sulfur amino acids being abundant. The essential amino acid index is similar to egg proteins but decreases after thermal treatment. Muscle & bone meal can be replaced with amaranth due to its amino acid content. Amaranth protein concentrate contains limited amino acids, while flour contains leucine, threonine, and valine [8].

iii. Quinoa

The study used Spearman rank correlation analysis to compare amino acid differences in quinoa samples. Amino acids were found in all samples, with glutamic acid and threonine having the highest presence. Aspartic

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acid, glycine, and arginine were in line, with average values of 3g/100g protein matter. Concentrations of different amino acids were less than 2.5g/100g protein.

3. **Legumes**

Food legumes, also known as grain legumes, are edible seeds grown worldwide and used as pulses in cereals. They enhance protein content and nutritional status, as cereal proteins lack essential amino acids like lysine [9].

This study analyzes the chemical composition of key food legumes like chickpea, cowpea, lentil, and green pea to determine their protein, amino acids, and mineral contents, highlighting their nutritional value based on cultivars, soil, and climatic conditions [10].

i. **Green Peans**

Green peas are a nutritious plant-based protein source with health benefits. It contains amino acids like lysine, arginine, and phenylalanine, and is well-tolerated by most people. Its high digestibility makes it a versatile option for various dietary needs. Green peas are rich in fiber, vitamins, and minerals, making them a sustainable and versatile option for a healthy diet [11].

ii. **Chickpeas**

Chickpeas, also known as garbanzo beans, are a nutritious legume rich in plant-based protein and essential amino acids. They are a versatile addition to a balanced diet, especially for vegetarians or vegans. Chickpeas are also rich in fiber, vitamins, minerals, and phytochemicals like flavonoids and polyphenols. They offer numerous health benefits and can be enjoyed alone or in various dishes [12].

iii. **Kidney Beans**

Kidney beans are a plant-based protein source with numerous health benefits, especially for vegetarians and vegans. They contain essential amino acids and are rich in dietary fiber, promoting digestive health, blood sugar regulation, and cholesterol reduction. They also contribute to environmental sustainability by requiring fewer natural resources and improving soil fertility. Kidney beans are a versatile and nutritious addition to any diet, promoting personal health and environmental sustainability [13].

iv. **Black Beans**

Black beans are a nutrient-dense legume with a high protein content and numerous health benefits. They provide a balance of essential amino acids, making them a crucial part of a balanced diet, especially for vegetarians or vegans. Black beans are also rich in dietary fiber, which helps regulate blood sugar levels, reduce cholesterol, and promote satiety, making them beneficial for weight management and metabolic health [14].

4. Nuts

True nuts, such as Brazil nut, cashew nut, pistachio, walnut, macadamia, nut, and chestnut, and seeds like peanut, are dry fruits with shells and thorns [15].

Baru almond, a pequi tree native to Cerrado regions, is rich in minerals like calcium, iron, magnesium, potassium, and zinc, with a greenish-brown fruit and edible almond seed.

The 'cerrado cashew nut', a Brazilian cashew species, has a high energy value, high lipid and protein content, and is widely used in juices, sweets, and liqueurs. However, its true fruit or nut is rarely consumed. Nuts and seeds are popular for health benefits and protein content, but their protein value, particularly in exotic varieties, is understudied, necessitating further research.

IV. ADVANTAGES

Protein components, including proteins with different molecular conformations and aggregation states, are crucial for functionality. Factors like concentration, type, shape, and aggregation state affect their performance. Other components like starches, fibers, lipids, and minerals also affect their performance. Textured plant proteins offer an economical, functional, and protein-rich food ingredient.

Plant proteins are primarily globular, covalently linked multimers, classified as albumins, globulins, prolines, and glutelins. Albumins are found in legumes and some pseudocereals, while prolamins and glutelins make up 85% of total protein. These proteins are composed of polypeptide chains folded into a tightly packed form by hydrophobic effects, hydrogen bonds, electrostatic forces, van der Waals forces, and disulfide bonds. Spherical proteins are good emulsifiers and foamers.

Plant-based protein sources are increasingly being explored to meet public nutrition needs. These sources may lack essential amino acids, such as lysine, but have good amounts of lysine. Nutrients vary due to soil diversity, climate, rainfall, and agricultural practices. Traditional plants like beans, peas, and soy are used,

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along with new and alternative sources like insect and algal proteins [16].

Table 2- PER, BV, NPU And PDCAAS score of various plant based protein sources

Protein source	PER	BV	NPU	PDCAAS
Soyabean	2.2	74	61	0.91
Buckwheat	2.5	77	63	0.92
Amaranth	2.7	75	65	0.94
Quinoa	2.9	83	74	0.96
Green Peas	2.1	65	53	0.85
Chickpeas	2.3	70	58	0.78
Kidney Beans	2.4	72	60	0.68
Black Beans	2.6	76	62	0.75
Peanut	2	67	55	0.52
Almond	2.1	69	57	0.47
Cashew	2.2	71	59	0.86
Walnut	2.1	69	57	0.86

(Source: Boye et al., 2012) [17]

Table 3- Chemical score of various plant based protein sources

Protein source	Chemical score (%)	Most limiting amino acid
Soyabean	100	None
Buckwheat	100	None
Amaranth	100	None
Quinoa	100	None
Green pea	65	Methionine + Cysteine
Chickpea	76	Methionine + Cysteine
Kidney bean	72	Methionine + Cysteine
Black bean	77	Methionine + Cysteine
Peanut	52	Lysine
Almond	47	Lysine
Cashew	86	Lysine
Walnut	86	Lysine

(Source: Samtiya et al., 2020) [18]

V. IMPROVEMENT IN FUNCTIONAL PROPERTIES OF FOOD

1. **Texture Enhancement:** Plant-based proteins can enhance the texture of food products, such as legumes and grains, by creating creamy or chewy textures.
2. **Emulsification:** They also have emulsifying properties, stabilizing emulsions and preventing ingredient separation in products like dressings and sauces [19].
3. **Foaming and Aeration:** Some proteins, like pea protein, can create stable foams for aerated food products [20].
4. **Gelation:** They can form gels under specific conditions, improving texture, consistency, and structural integrity.
5. **Nutritional Enrichment:** Plant-based proteins also provide essential nutrients, such as amino acids, vitamins, minerals, and dietary fiber, enhancing the nutritional profile of food products.

VI. ENVIRONMENTAL ADVANTAGES

1. **Reduced Greenhouse Gas Emissions**: Plant-based proteins have a lower carbon footprint than animal-based proteins, reducing greenhouse gas emissions from livestock agriculture, particularly beef and dairy production.
2. **Conservation of Natural Resources**: Plant-based proteins, like legumes and grains, are more resource-efficient than animal-based proteins, as they require less land, water, and energy to produce equivalent amounts of protein [21].
3. **Preservation of Biodiversity**: Promoting plant-based proteins can help conserve biodiversity by reducing land conversion and preserving natural habitats, as large-scale animal agriculture often leads to deforestation and habitat destruction [22].
4. **Water Conservation**: Plant-based proteins have a lower water footprint compared to animal-based proteins, as legumes and grains

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require less water for production, reducing water scarcity in many regions.

5. **Reduced Pollution**: Animal agriculture contributes to water and air pollution through manure, chemical fertilizers, and livestock waste. Transitioning to plant-based proteins can mitigate these issues [23].

VII. CONCLUSION

Consumers prefer plant-based alternatives to animal foods, leading to food industry development. Plant-based proteins from soybeans, legumes, pseudocereals, and nuts offer health and environmental benefits, diverse flavors, textures, and culinary applications. They are rich in essential amino acids, vitamins, minerals, and phytonutrients.

Plant-based proteins enhance food's functional properties, providing texture, emulsification, foaming, and gelling, and are versatile ingredients in meat alternatives and baked goods, improving sensory characteristics. Plant-based proteins have a lower environmental impact than animal-based ones, requiring less water, land, and energy to produce and reducing greenhouse gas emissions. They can help mitigate deforestation and biodiversity loss associated with livestock farming, promoting sustainability and aligning with global efforts to combat climate change and promote sustainable development.

In summary, incorporating plant-based proteins into our diets offers numerous advantages, including improved health outcomes, culinary versatility, enhanced functional properties in food products, and reduced environmental impact. By diversifying protein sources and embracing plant-based alternatives, we can foster healthier lifestyles and contribute to a more sustainable future for generations to come.

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