Ecofarming
e-Magazine for Agriculture and Allied Sciences
http://www.ecofarming.rdagriculture.in
e-ISSN: 2583-0791

Plant Protein Blends

A Way Forward

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Received: February, 2024; Accepted: February, 2024; Published: April, 2024

Introduction

Consistently, ensuring proper nutrition in a well-balanced manner is a fundamental requirement for everyone. Malnutrition, a chronic dietary limitation condition, encompasses various disorders, with protein malnutrition being the predominant concern affecting around 70% of the Indian population. To address this issue, it is crucial to consume foods with excellent protein quality and other essential properties.

Although animal proteins are widely consumed globally, factors such as increasing popularity of veganism, economic lifestyles, and growing health consciousness regarding obesity and cardiovascular problems have limited their consumption. Anticipated increase in global population and incomes, particularly in developing nations, suggest a rising demand for animal protein. However, challenges such as limited arable land and escalating feed ingredient prices underscore the need for greater efficiency in nutrient utilization to produce animal protein without inflating production costs.

Addressing the question of how to obtain high-quality protein through our diet, a noteworthy and promising solution is the utilization of plant-based sources and their proteins (Mota da Silva et al., 2021). Consumed predominantly, foods serve as key tools for enhancing quality and other formulation-based attributes, making them a primary focus in the food market. Additionally, high-quality plant proteins have been noted for their potential to lower the incidence of various metabolic diseases, including diabetes, cancer, and heart-related conditions.

Numerous studies highlight the potential of by-products from cereals, legumes, and oilseeds (such as wheat, barley, soybean, peanut, canola, groundnut, flaxseed, grape seed, sesame seed, cottonseed, pumpkin seed, rapeseed, sunflower) as protein sources beneficial for human nutrition and cardiovascular health. These by-products encompass bran, defatted meals, and leaves. Therefore, in-depth investigations are necessary to discern the functional characteristics and monomeric units

of each plant protein extracted from these components.

Before blending, an evaluation of quality and functional parameters, along with estimating the amount of protein isolate required to achieve a balanced amino acid profile in our diet, is imperative.

Protein, a versatile nutrient

Proteins serve as essential nutrients vital for a wide range of physiological and structural functions, contributing to sustainable and balanced living. They play a crucial role in enhancing muscle mass, promoting growth, and facilitating the development of efficient and active bodily functions. Every component of our body contains proteins, acting as diverse molecules such as enzymes, transporters, globin molecules, muscle proteins, structural proteins, membrane proteins, signalling proteins, hormones, and neurotransmitters, highlighting their essentiality and versatility (Kumar et al., 2022a; Sim et al., 2021).

Considered a key nutritive component in our diet, proteins have a recommended daily allowance (RDA) of approximately 0.8g/kg for adults, excluding those in non-pregnant, non-recovery, and non-lactating conditions. Adequate protein intake is essential for activities like muscle wellness, immune system maintenance, cell repair, and various signaling processes, establishing protein as an indispensable nutrient in our bodies. The primary goal of protein consumption is to supply essential amino acids, crucial for diverse bodily functions (Pam Ismail et al., 2020).

Amino acids are categorized as essential and non-essential. Non-essential amino acids can be readily synthesized by our bodies, while essential amino acids must be obtained through daily meals. Consequently, individuals must select and consume suitable food products balanced in all essential amino acids. A balanced amino acid profile is intrinsic to animal protein, whereas plant protein may lack two or three essential amino acids.

A variety of protein sources, including animal protein, plant protein, and single-cell protein, are commonly consumed. Proteins exhibit dynamic characteristics influenced by their source, extraction methods, processing techniques, determining outcomes, yield, complex matrix formation, and other technological functionalities. Recognizing their significant nutritional value, alternative protein sources are being developed to introduce innovative ingredients for their indispensable inclusion in food formulations, accompanied by improvements in physio-chemical and other functionality parameters (Jiménez-Munoz et al., 2021)

Legumes are quite often rich sources of protein (20–40%), especially when eaten along with cereals. The proteins are utilized as functional ingredients, either as concentrates or isolates, primarily to improve nutritional quality and provide designed food products with desirable sensory qualities like structure, texture, flavour, and colour. Food producers and consumers are searching for alternative protein sources due to dietary limitations and preferences. The majority of protein concentrates and isolates used by the food industry today are made from soy, whey, and wheat. Because of their high protein content, low cost, and widespread acceptance, legumes can be characterized as the most appropriate for the production of protein isolates (Shevkani *et al.,* 2015).

Plant protein as a future food

By the growing population and its urge to fulfill its nutritional requirement, alternative protein sources have been coming up. In recent times, consuming animal protein as a major protein source is found to be declining due to the facts like unavailability of land and resources, higher cost of meat, health-conscious consumers, and increased rate of veganism (Sim *et al.,* 2021). Adding to that, an enormous study was done on plant protein in recent decades to achieve novelty-based food grade ingredients followed by its application in food industries. Hence,

plant protein is considered to be an easy avail source of nutrition in continuation with the facts like lower cost of production, increased availability of resources, economically feasible, ecologically friendly, and so on. Consuming plant-based protein additives is considered to significantly minimize the cause of several metabolic diseases, such as cardiovascular disease, obesity, diabetes, and other health-related illness.

On the other hand, the plant protein market is increasing at an highest rate due to its derived benefits among consumers. It is projected to reach around 15.6 billion USD in the year 2026 and grow at a value of 10.3 billion in the year 2020 with a CAGR of 9.7%. Owing to that, the increase in soy-free, gluten-free health habits is considered to give rise to great confront for the global plant protein marketers and manufacturers. As the two sides of the coin, these foods are known to be more nutritious as well as more allergic, posing a major threat to food consumption. Therefore, the search for alternatives in plant protein sources is much needed as a substitute for these.

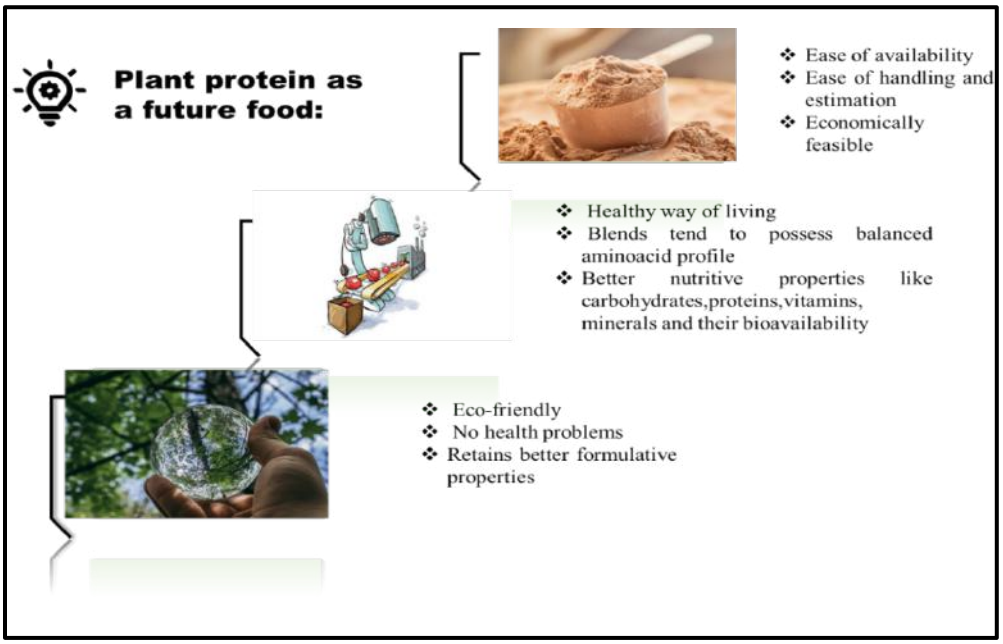

Figure-1: Benefits derived out of utilizing plant protein as a future food

Essentiality of protein blends

Individual plant proteins do not offer a well-rounded amino acid composition, lacking some essential amino acids. A comprehensive amino acid profiling was conducted, comparing various plant protein sources such as oat, lupin, wheat, hemp, microalgae, soy, brown rice, pea, corn, and potato, alongside specific animal protein sources like milk whey, caseinate, casein, egg, and human skeletal muscle protein. Unlike animal proteins, most of which have a PDCAAS value of 1, plant proteins exhibit significant variability. Therefore, it is recommended to combine plant proteins from different sources to achieve a balanced amino acid profile, contributing to improved health, enhanced anabolic properties, and overall growth. Consequently, protein blends with a composition of essential amino acids emerge as a crucial and sustainable source of nutrition to meet global protein requirements.

The ability to replicate the fibrous structure of animal meat is essential for meat analogs, and successful utilization of blends has been demonstrated for this purpose (Schreuders et al., 2020). The production of protein blends proves effective in achieving a balanced amino acid profile. Recognizing the deficiencies and richness of certain amino acids in cereals and pulses, respectively, blending them in specific ratios can yield a complete protein (Kaleda et al., 2021). Aligning with this concept, studies on protein blends suggest their practical

significance in the formulation of balanced food products.

Pea and rice protein blends were done with a ratio of 2:1 to substantiate an appropriate quantity of methionine and lysine to meet the recommendations. Double steam injection processing was included as one of the processing methods which helps in the improvement of functional properties like solubility, foaming properties, and surface hydrophobicity without affecting its nutritive profile (Pietrysiak *et al*., 2018)

Kristensen *et al.,* (2021) conducted experiments in pea-whey protein blends as well as co-precipitates and reported that protein blends show the highest solubility (measured in terms of turbidity) than the co-precipitates with an increased pH (3,7,11.5). The increase in solubility is mainly due to electrostatic repulsion, to counter the decreased solubility of co-precipitates because of higher interaction between proteins. Further, the foaming stability of blends was analyzed by visualizing under light scattering and light microscopy and reported that stability of emulsions by maintaining the droplet size in a four weeks interval which also enhanced in pace with higher solubility. They also reported that the decrease in particle size at pH 11.5 than pH 7 that signifies the increased stability at higher pH due to a higher net charge that prevents coalescence. Thus, these studies suggest that protein blends have an imperative role in extending their nutritional and functional application in food formulations for the benefit of humans.

Chickpea-rice-peanut: A perfect trio of plant protein blends

In our study, I had taken three main crops for the preparation of the protein blends, viz., peanut cake, chickpea, brown rice, most nutritive in the field of oilseed, pulses and cereals respectively. It could be a perfect blend as it is blended in the ratio in order to meet the daily requirement of protein with all the essential amino acids in it. Protein isolate was extracted by ultrasonicated assisted alkali extraction followed by iso-electric precipitation. After the extraction of protein isolates, all the nutritional and functional parameters were estimated for the individual protein isolates viz., protein content, digestibility, amino acid content by UPLC, water and oil absorbing capacity, secondary structure determination by FTIR, Structural morphology by SEM. Blends was found to have higher protein content and better digestibility compared to that of individual protein isolate. It was also encountered that it has all the essential amino acids with a better score which overcome the limitation that cereals lack lysine and pulses lack methionine. Incorporation of steam infusion on the protein blends enhanced the protein content, protein digestibility and other functional properties which also reduced the anti-nutritional properties. Determination of secondary structure by FTIR revealed that β-sheets and β-turns was found to be higher in case of SIPB compared to that of NSIPB whereas no significant difference was observed in the a α-helix structure. The results of surface morphology study by SEM shown to possess smoother and homogenous structures in case of NSIPB whereas rougher, dispersed and porous structures was found for SIPB.

Conclusion

Peanut-chickpea-rice protein isolate blends - promising source for the future protein market due to its improved nutritional properties with a tag of complete protein. Highly beneficial for the food industries to develop stable food emulsion systems using these protein blends. Although steam infusion causes improved protein content and protein digestibility, incorporation of processed blends in the commercial plant protein market needs an enormous study in terms of storage, sensory & textural characteristics; thorough study on the stability attributes, implementing further processing methods which could deal with every aspect of techno-functionality.

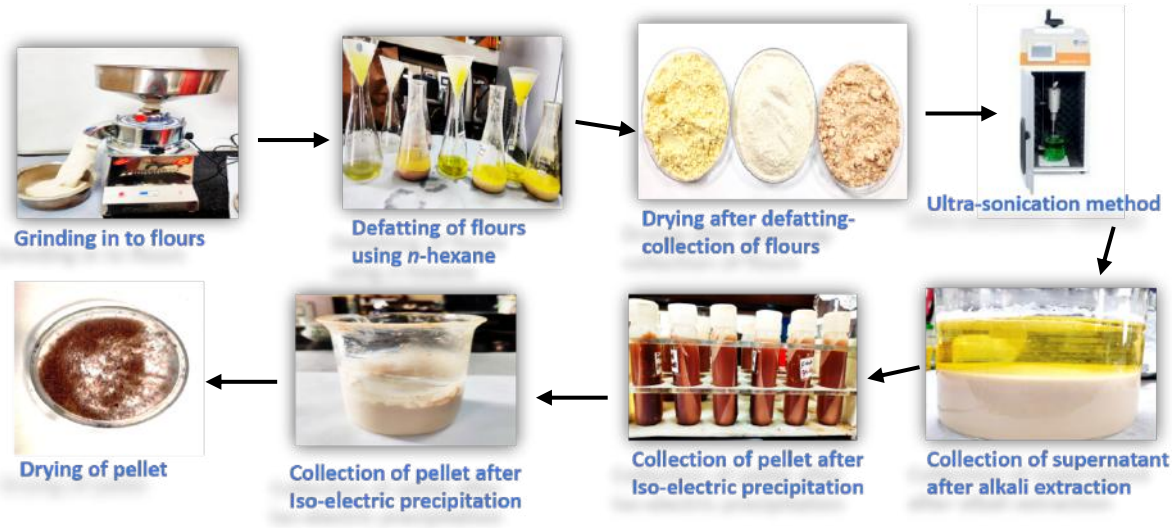

Figure 4: Process of protein isolate extraction

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