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(REVIEW ARTICLE)

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Effective plant protein extraction to enhance plant protein functionality and impact of plant protein over animal protein on health

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Abstract

Plant proteins extracted with traditional method are generally of lower quality, with a less favorable amino acid profile as compared to animal protein. This review explores effective protein extraction methods to enhance plant protein functionality. Moreover, animal protein is associated with high risk of cardiovascular disease and other disease. This review will highlight the impact of plant protein over animal protein on cardiovascular disease and other health Issues.

Keywords: Cardiometabolic Health; Animal Protein; Plant Protein; Cardiovascular Risk; Plant Based Protein (PBP); Randomized Control Trial (RCT).

1. Introduction

Protein plays a vital role as an indispensable macronutrient in human nutrition. The utilization of new protein sources from plants requires a thorough investigation for application in foods. Functional characterization is the most important step for the quality assessment of protein along with annotating the protein with a specific application in food systems. The evaluation of plant protein for quality and functional properties is critical in replacing conventional animal-based proteins (7).

The market demand for plant-based proteins has recently gained momentum due to their health benefits and eco-friendly origin compared with animal proteins. However, plant-based proteins have lower solubility, lower techno-functionalities, poor digestibility, and anti-nutritional factors which restricts their application in the food processing sector (3).

The potential beneficial effects of plant-based diets on human health have been extensively studied. However, the evidence regarding the health effects of extracted plant-based proteins as functional ingredients, other than soya, is scarce (4). The effect of plant-based diets on cardiovascular risk factors, particularly plasma lipid concentrations, body weight, and blood pressure, and, as part of a healthful lifestyle, reversing existing atherosclerotic lesions, may provide a substantial measure of cardiovascular protection. In addition, plant-based diets may offer performance advantages. They have consistently been shown to reduce body fat, leading to a leaner body composition. Because plants are typically high in carbohydrate, they foster effective glycogen storage (9).

A proper Method for high quality plant protein extraction is still under process. Further research is required to develop standard protein extraction method. Moreover, research found about plant and animal protein comparison are too general. More research to be conducted to isolate the role of plant and animal protein on cardiovascular risk and other health issues.

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This review aims to provide clear understanding of the effects of plant protein over animal protein on cardiovascular disease and overall health. In addition to that it also focuses on proper protein extraction method to enhance protein functionality.

2. Methods

PubMed, Research Gate and Web of science databases were searched using combination of the terms plant protein, animal protein, Plant protein extraction methods, functionality of protein, Effect of plant protein on cardiovascular disease, and plant protein effect on health. The results are screened using the following inclusion criteria: availability as full text in English; published between 2010 and 2024; and categorized as original research, a review, a systematic review. Titles and abstracts were screened for the above criteria and relevance to the search topic. Articles that did not have the relevance with the title were excluded.

3. Results

The area of plant protein study is diverse and it is growing gradually. Critical analysis of the existing literature highlighted key considerations, characterizations, and definitions that are addressed herein. Additionally, the literature revealed plant protein functionality, several positive health outcomes impacted by plant protein, which were categorized into the following four classifications: Protein Extraction Method, Protein Functionality, Plant Protein and cardiovascular Disease, Effect of protein on Other Diseases. Each category is further elaborated through a detailed discussion of the relevant literature by addressing studies conducted in that area. This was followed by gap analysis and recommendation for further research on that field.

4. Discussion

4.1. Protein Extraction Method

Traditional method of plant protein extraction provides low quality protein. Further investigation is required to specify integrating chemical, enzymatic, thermal, and non-thermal methods can address challenges in plant protein production [11,12]. These combined approaches reduce negative consequences associated with individual treatments, minimizing the production of toxic by-products commonly associated with chemical treatments. Moreover, it helps mitigate the undesirable effects often observed during thermal treatments. Additionally, combining these methods can lead to cost reductions in enzymatic treatments. Overall, the synergistic utilization of these techniques provides a comprehensive and advantageous strategy in various applications (2).

The extraction yield of proteins can be reached up to 86–95% with high functional properties using sustainable and efficient routes, including enzymatic, ultrasound-, microwave-, pulsed electric field-, and high-pressure-assisted extraction. Nondairy alternative products, especially yogurt, 3D food printing and meat analogs, synthesis of nanoparticles, and bioplastics and packaging films are the best available PBPs-based products. Moreover, PBPs particularly those that contain pigments and their products showed good bioactivities, especially antioxidants, antidiabetic, and antimicrobial (5).

4.2. Protein Functionality

Various methods, including enzymatic hydrolysis, chemical modifications, and physical treatments, can enhance plant-based proteins' functional properties. These techniques improve solubility, gelation, emulsification, foaming, and other desired functionalities (2).

Dietary protein variety is also key for meeting indispensable amino acid requirements. While the Protein Digestibility Corrected Amino Acid Score (PDCAAS) of an individual protein is critical when evaluating the quality of a sole-source protein, it becomes less significant when the diet contains proteins from many sources. For example, lysine is often limiting in grain proteins, but such proteins are good sources of the sulfur-containing amino acids. On the other hand, legumes are often rich sources of lysine but are limiting in sulfur-containing amino acids. Consumption of these two protein sources over the course of the day allows them to "complement" one another, helping to meet requirements for both types of indispensable amino acids (1).

The exposure of the protein to the ultrasound improves the gelation characteristics of the protein. The formation, growth, and bursting of the cavity bubble results in increasing the temperature and pressure which significantly improves the gelation characteristics of protein (3).

In food formulations Plant-based proteins play important roles, including acting as gelling, thickening, and foaming agents, and have emulsion stabilizer, water and fat binding actions. Moreover, plant-based proteins also have biological functions such as antimicrobial and antioxidant activity (7).

Improving the functional properties of plant-based proteins is a challenge. Extensive research and development efforts, including implementing innovative strategies, can enhance these properties, expanding the applications of plant-based proteins in various food products. Process optimization, covering extraction methods, heat treatments, and high-pressure processing, positively affects plant protein functionality by addressing solubility, gelation, and foaming challenges. The synergistic application of diverse approaches and optimized processes maximize the utilization of plant-based proteins in the food industry.

4.3. Plant Protein and cardiovascular Disease

The majority of studies reported a beneficial effect of extracted plant protein on regulating postprandial glycaemia, in comparison to either, placebo or other proteins, including soya; however, the effects varied by study design (4).

Meta-analyses of RCTs suggested a protective effect on total cholesterol (mean difference -0.11 mmol/L; 95% CI -0.22, -0.01) and low-density lipoprotein cholesterol (-0.14 mmol/L; 95% CI -0.25, -0.02) by replacing animal protein with plant protein. The substitution of animal protein with plant protein (percentage of energy intake) in cohort studies was associated with lower CVD mortality (n = 4) and lower T2D incidence (n = 2). The evidence was considered *limited-suggestive* for both outcomes (13).

More research should be conducted on different group of population to find out what type of cardiovascular risk can be reduced with protein. Different intervention study can be conducted to have better outcome from the plant protein.

4.4. Effect of Plant protein on Diabetes

Diets emphasizing a replacement of animal with plant protein at a median level of ∼35% of total protein per day significantly lowered HbA_{1c} (MD = −0.15%; 95%-CI: −0.26, −0.05%), FG (MD = −0.53 mmol/L; 95%-CI: −0.92, −0.13 mmol/L) and FI (MD = −10.09 pmol/L; 95%-CI: −17.31, −2.86 pmol/L) compared with control arms. Overall, the results indicate that replacing sources of animal with plant protein leads to modest improvements in glycemic control in individuals with diabetes (14). This, however, will require further research to identify indicator other than glycaemia control affecting diabetes.

4.5. Effect of Plant protein on Other Diseases

Dietary guidelines recommend a change towards a plant-based diet that is more sustainable for health and for the environment; however, reduction of animal-based foods may impact protein quality in the diet. High quality protein is important for maintenance of muscle health in older age; therefore, there is a need to understand whether replacement of animal protein with plant protein will make a significant difference in terms of muscle health outcomes (6).

5. Conclusion

Plant-based diets play a key role in controlling cardiovascular disease, diabetes and other health issues. Specifically, these diets improve plasma lipid concentrations, blood pressure, body weight, and blood glucose control, and, as part of a healthful lifestyle, have been shown to reverse atherosclerosis. The possibility that such diets may also contribute to improved performance and accelerated recovery is raised by their effects on blood flow, body composition, antioxidant capacity, systemic inflammation, and glycogen storage. These attributes provide a scientific foundation for the increased use of plant-based diets by people achieving this goal requires substantial research efforts and collaboration across multiple scientific disciplines to identify and address the existing knowledge gaps. The importance of pursuing such research cannot be overstated, as these gaps in knowledge may be unknowingly and insidiously compromising the health of people.

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