



A REVIEW ON PLANT-BASED PROTEINS

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ABSTRACT

There has been observed an increasing popularity around the globe in plant-based protein and plant derived alternatives to meat and animal-based products both online and when one visits the supermarkets and grocery stores. The aim of this review is to better understand what impacts this new revolution can have on us and the environment as we know it right now.

From the standpoint of global sustainability, plant-based foods are proposed to be advantageous over animal-based foods. It has been suggested that the production of plant-based foods requires less water, land, and energy. This may ultimately pose less environmental burden and lower the financial cost of food production. These notions likely explain the increasing interest in the potential of using plant-based protein sources in clinical feeding formulas and sports nutrition supplements.

In terms of overall health, it has shown to significantly aid in lowering cholesterol levels in people and therefore reducing the risk of cardiovascular diseases (CVD). Some studies have shown that it helps in controlling type 2 diabetes but the research on that is very little. In terms of menopausal symptoms, studies showed that it was beneficial for those women to have certain plant-based proteins. Understanding the role of plant protein in cancer prevention is discussed.

Other aspects such as muscle growth and its effects on strength are also discussed.

KEYWORDS: Plant protein, effect on health, environmental impact, MPS, amino acids

INTRODUCTION

Climate change has been a great contributor for people to believe that we need to shift to a diet that is more sustainable and can reduce the total GHG (green-house gases) emissions. Consumption of plant-based protein alternatives has increased in western countries especially among those sects of the populace that are more willing to shift to a plant-based diet, of them women being a majority and the majority age group being millennials. There

has been a dramatic increase in the number of vegans in the western countries since 2011 till 2018²².

A lot of the vegetarian and vegan population consumes most of their protein from soy and soy products since it has the highest amount of protein among all other plant-based sources of protein and

has a better digestibility¹⁹. Soy is one of the most widely used and studied plant protein.

Growing concerns about animal welfare also have made people think about a better alternative for livestock³⁵. Globally it is estimated that around 75 billion terrestrial animals were slaughtered in 2017 to provide demand for meat and other protein rich, animal derived foods. And those effects aren't minimised on smaller scales either³².

There has been some skepticism regarding switching towards a more plant-based or a solely plant-based diet because of the protein quality. Protein quality relates to the composition of amino acids in it and their digestibility after consuming. Animal proteins contain all 9 essential amino acids and their digestibility is at least 95% whereas plant sources such as soy and pea do not contain sulphur containing amino acids (methionine and lysine) and some lack leucine as well and their digestibility is close to 90% or less^{3,4,18,31}. Recent studies show that the digestibility of plant proteins can be increased by encapsulating them in polysaccharides beads. These behave very similar to plant proteins and may eventually replace animal proteins but the research is limited on that¹⁸.

It was observed that heating processes and other food processing techniques, one of them being fermentation, the toxic compounds and antinutritional factors in soy protein significantly decreased and the IVPD (In vitro protein digestibility) becomes 100%^{6,17}.

Fermentation increases the protein content of food products because the main energy source of the microbiota involved in the fermentation process is glucose; when these microbiomes eat away at the carbohydrate content of the plant protein, the protein density of the food increases.¹²

A growing body of research suggests that protein from plants may be used to decrease risk of development and spread of colorectal cancer. Effects on type 2 diabetes are also studied but there are inconsistencies among studies.

Muscle protein synthesis (MPS) is an important factor for athletes, people who do resistance training (RET) and people who are older in age. And despite certain issues with digestibility and its effectiveness in providing stimulation for MPS there are certain methods that can be applied to increase the stimuli for MPS.

HEALTH BENEFITS

Consuming protein in the form of animal products in western diets has shown increasing association with cardiovascular diseases and other chronic diseases such as diabetes. It is also shown to be associated with higher risk of cancer.

Plant protein sources such as soy contain isoflavones, bioavailable iron, calcium, magnesium, dietary fibre and polyunsaturated fatty acids. It contains antioxidants such as phytate and isoflavonoid which result in lowering cholesterol, decreasing considerably the symptoms of menopause and avoiding cancer.¹³

In a study conducted in Helsinki, Finland; three groups were made: 'ANIMAL' group which obtained 70% of its protein from animal products and 30% from plant sources; a '50/50' group which sourced 50% of its protein from animals and 50% from plants; and a 'PLANT' group which consumed 70% of its protein from plant sources and 30% from animal products. Nutrient intake was assessed by 4-day records over 12 weeks. They received results that participants from the 'PLANT' group were consuming less protein than their 'ANIMAL' or '50/50' counterparts; dietary fibre intake of the 'PLANT' group was a lot higher than 'ANIMAL' group and cholesterol levels of 'PLANT' and '50/50' group were significantly lower than 'ANIMAL' group.

It was overall inferred that a mainly plant focussed diet improves dietary fatty acid composition. Although it is important to note that participants from that group reported intestinal discomfort. Furthermore, it may be difficult for people over 65 years to adopt a plant-based diet as they require a higher intake of protein.²

In another study, it was observed that replacing lean meat with plant protein alternatives did not produce a significant difference in the dietary fatty acid composition. Substituting high quality plant proteins in stead of red meat is better than substituting low quality carbs or fish instead of red meat because blood lipid levels were shown to have decreased. Plant protein also showed an increase in HDL-C and a decrease in LDL-C and an overall reduction in cholesterol^{10,28}.

Diabetes: Diets low in whole grains were ranked as the main risk factor for deaths due to sub optimal diets in countries like India, the USA, Russia, Pakistan, Nigeria, Brazil, Germany, Egypt, Iran and Turkey²⁷. Some studies that were conducted showed that insulin resistance decreased quite a bit

after consuming plant protein products (soy)¹. Since legumes have high fibre and protein content and low fat and glycemic index (GI), they are considered to be a good introduction to the diets of people with diabetes. Although there are inconsistencies with this claim, health officials do believe that a higher amount of plant-based protein may be helpful for patients with diabetes but we can't say for sure that it increases insulin sensitivity in individuals that are not sensitive to insulin^{11,29}.

Cancer: MMP-2 and MMP-9 are 2 of the metalloproteinases that play a major role in metastatic progression of colorectal cancer. Their (MMP-2 and MMP-9) activity was shown to have reduced significantly by consuming legumes, lupins, soybeans and chickpeas, more specifically, the hydrophilic phenolic compounds found in them^{11,34}.

Menopausal symptoms: women going through menopause experience symptoms such as hot flashes, genital epithelial atrophy and osteoporosis to name a few. Isoflavones which are mainly found in plant protein sources such as soy and peas are used as a safer alternative to hormone therapy but soy protein on its own is not responsible for the improvement in bone health of women in menopause¹⁶.

A study conducted by Chen, Ko and Chen showed that women who were eating soy and soy products experienced less symptoms as compared to the placebo group¹⁵.

ENVIRONMENTAL IMPACT

Food systems are responsible for 21-37% of global GHG (green-house gases) emissions and livestock production is responsible for ~14.5% GHG from human activities, 15% groundwater use and 12% of water pollution.^{32,25}

LCIA (life cycle impact assessment) offers a way to evaluate diet choices environmentally and eco indicator is a number that shows the environmental impact of a process after its life cycle assessment. Higher the eco indicator, higher the impact. The environmental impact of animal-based sources of protein was much higher than plant-based sources. The fossil fuel requirements were 6-20 times higher; emission of acidifying substances was also more than 7 times higher than for plant sources. On average, animal protein production requires 10 times the resources in terms of land than plant protein production. Grazing of the livestock created

more disruptions in biodiversity and contributed in worsening the nutrient cycle of ground water and led to eutrophication. Water was also found to be used in the animal protein production than plant-based protein production: about 4.4 to 26 times higher. The biocides or pesticides used were also 6 times higher than in plant protein production. Phosphate rock (a natural, non-renewable source used to synthesize fertilizers) is also more extensively used (about 7 times higher) in animal protein production. Phosphate rock can contaminate other foodstuffs and soil and find its way into the human body.³²

Feed production for the animals was a major cause for pollution resulting from animals. Ruminating animals were the main source of methane emissions from animals. As far as poultry is concerned the major source of pollution again comes from feed production, the slaughtering of the poultry animals on the other hand proves to have no significant impact in that category, although there is high variability in the data. Plant based sources had the least impact^{25,26,33}.

But it should be understood that 52% land devoted to livestock is arid and cannot be used by humans to grow crops and consume directly. And the cattle that feed on this arid land help in converting the non-edible protein to edible protein.³²

IMPACT ON MUSCLE GROWTH

Two main requirements for stimulating MPS (muscle protein synthesis) are: food intake and more specifically dietary protein intake and physical exercise.

Not a lot of studies have been done to show the extent to which the muscle mass reacts to the specific protein source as there are that show plant-based protein can avoid protein deficiency.

Multiple studies based on soy-based protein have showed that 17.5-40g of soy protein do not increase MPS as much the same amounts of whey protein, skimmed milk or beef both in resting or post exercise conditions. Since plant-based protein such as soy and wheat protein has been proved to more readily convert into urea, it is less suitable of a stimulus for MPS as compared to whey protein^{6,31}.

Aging entails a loss of muscle mass also known as sarcopenia, when MPD becomes greater than MPS. In older men, it was observed that when they ate about 40g of soy protein their leucine oxidation levels were elevated which suggested that more amino acids were being oxidised rather than being

used for MPS. However, no significant change was observed in strength of participants in the study^{5,3}. On a long-term basis there was no significant difference in MPS between people who were eating plant protein and exercising and people who consumed animal protein.³⁰

We can improve the anabolic response of skeletal muscles towards plant proteins by fortifying them with free amino acids, eating from a more varied range of plant proteins, this might allow all essential amino acids to be present in a person's diet; and eating more amounts of plant protein.⁶

ADVERSE EFFECTS

Although plant-based foods as a whole seem to be better for the environment and also the human body, there may be some drawbacks to them.

A lot of animal substitute plant-based products have started showing up in grocery stores, but there are not many specific moderations or rules for them. In order to appeal to a greater population, these foods are processed to mimic animal-based foods, due to which, they can be considered as ultra-processed foods. They have a higher amount of sodium in them as compared to animal protein. The plant alternatives also showed to have a higher amount of carbohydrates and were lower in energy. Furthermore, a study conducted in Australia showed that only 24% of the total products were fortified with vitamin B12. A lot of products fell short in terms of similarities with meat with respect to vitamin B12, zinc and iron^{9,26}.

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Apart from tofu and mycoprotein fewer plant-based sources of protein have been tested for their physiological effects on consumers. It is safer for consumers to check what sources they are getting their nutrients from and to make sure not to neglect any nutrients obtained from meat^{21,28}.

CONCLUSION

Limited data on oestrogen and its role in preventing cancers and epithelial atrophy. There need to be more studies conducted to definitively know its effects. For menopausal symptoms as well, there aren't enough studies. Different groups of women showed different responses to soy isoflavones. We also don't know which part of the isoflavones are beneficial to treating the symptoms.

The environmental effect is one of the most talked about aspects of a more plant-based focus towards food but there are differences in findings because of the different types of both plant and animal protein sources. Most papers talk about beef when talking about the animal protein sources which are responsible for the contribution to GHG emissions from the food industry. There isn't a lot of research done on the contribution of poultry and dairy industry to GHG emissions, so we don't have the full picture about how adopting plant-based protein could significantly alter GHG emissions.

The general body of research does point to the fact that plant-based diets could be better for humans in the sense of planetary and human health, but we still need more researches.

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