Main plant protein sources and diet quality across vegan, vegetarian, pesco-vegetarian and semi-vegetarian diets

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Introduction

Consumer demand for plant-based products is rapidly growing for health reasons, environmental sustainability concerns as well as ethical issues regarding animal welfare. The nutritional quality of plant-based proteins is lower than that of animal-based proteins because of the limited amount of selected essential amino acids, leading to the concept of *limiting amino acids*. Plant proteins should therefore be consumed in combination in order to serve as complete proteins and allow for optimal protein synthesis.

Research objective

We compared plant-protein source quality and diet quality across four primarily plant-based diets: vegan, vegetarian, pesco-vegetarian and semi-vegetarian.

Methods

Systematic review of publications from 2002 to January 2023.

Protein quality was characterised across these diets as:

- Plant and animal protein % contribution based on total protein intake
- Plant protein food sources reported were clustered based on their limiting amino acid profiles.

Table 1. Plant protein sources with respective limiting amino acid profiles, PDCAAS and DIAAS.

Plant Protein sources [a]	Foods	Lysine limiting	Methionine limiting	No limiting amino acid	PDCAAS [b]	DIAAS [b]
Grains	Wheat	X			0.54	0.39
	Rice	X			0.64	0.52
	Oat	X			0.62	0.44
	Quinoa	X			0.84	NA
	Corn	X			0.5	0.38
Nuts	Almond	X			0.44-0.47 [c]	NA
	Peanut	X			0.55	0.47
Pulses	Pea		X		0.91	0.66
	Lentil		X		0.8	0.75
	Chickpea		X		0.71	0.69
Beans	Fava bean		X		0.67	NA
	Kidney bean		X		0.74	0.61
	Soy			X	1	0.92

[a] Plant protein foods were grouped into grains, beans, pulses and nuts (British Nutrition Foundation 2021) [b] Protein digestibility amino acid score (PDCAAS) and digestible indispensable amino acid score (DIAAS) of protein plant sources based on children older than 3 years up to adults. Optimal protein quality: PDCAAS 1 and DIAAS > 1 (Food and Agriculture Organization 2013; Hertzler et al. 2020) [c] Measured PDCAAS of almonds (House et al. 2019)

- The contribution % from each of the three limiting amino acid clusters was determined by:

$$\frac{\textbf{Sum of mean intake from foods in "lysine limiting" cluster (unit)}}{\textbf{Total plant proteins (unit)}} \times 100$$

$$(sum\ of\ mean\ intake\ from\ all\ plant\ protein\ foods\ reported\ consumed)$$

Results

Studies included:

- Observational studies
- 21-97,124 participants
- High income countries
- Predominantly female
- Aged ≥ 18
- Reported on protein intake/sources (n=12), overall diet quality (n=2) or both (n=1)

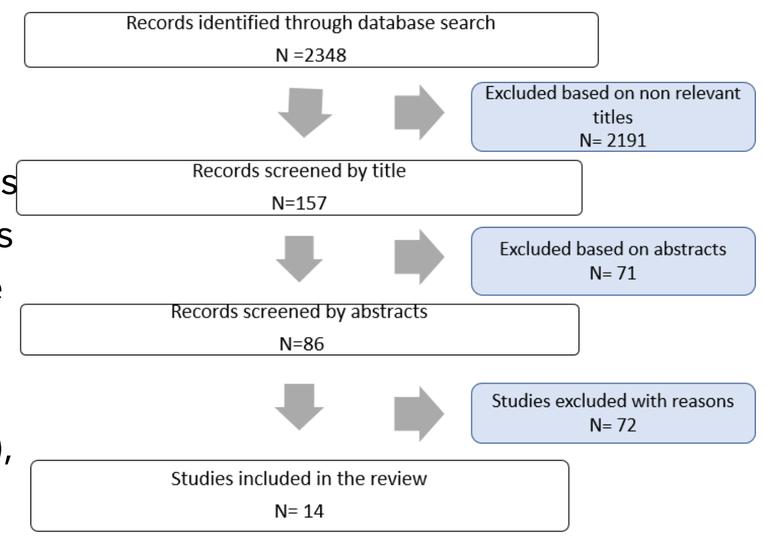

Figure 1. Flowchart for studies selected for inclusion.

Table 2. Plant and animal protein % contribution based on total protein intake and most used plant-based diet definitions reported in some studies

Plant based diets (N studies)	Most used definition of diet	Plant protein %	Animal protein %
Vegan (n=3)	Exclude any animal products	75 to 100 %	0 to 25 %
Vegetarian (n=5)	Exclude all animal foods except for eggs and dairy	50 to 86 %	14 to 50 %
Pesco-vegetarian (n=3)	Exclude meat but consume fish	49 to 81 %	19 to 51 %
Semi-vegetarian (n=4)	Reduce intake of animal source foods *	37 to 83 %	17 to 63 %

* The semi-vegetarian diet definitions on frequency and amounts were different across all studies

- The presence of animal protein in vegan diets was from participants self-reporting as vegan and having a less strict vegan definition allowing for small amounts of animal foods per month
- The diet quality results were inconclusive due to the scarcity of studies.

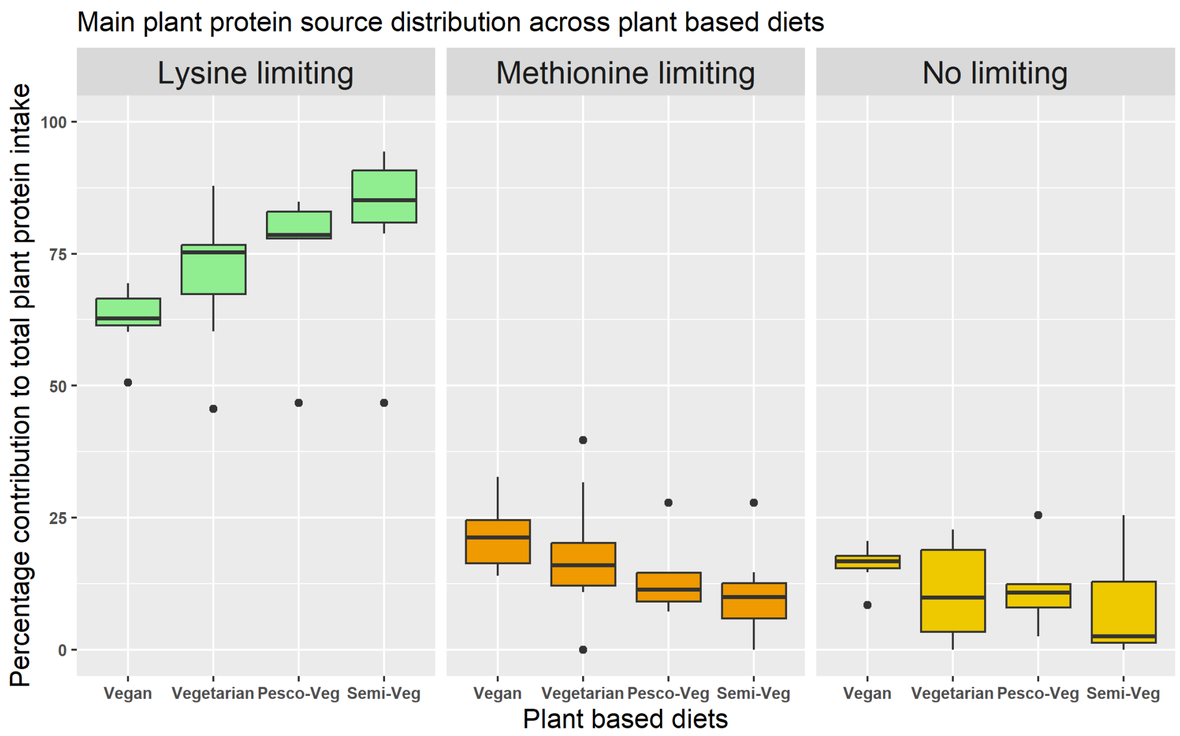

Figure 2. Main protein sources consumed across the vegan (n=7), vegetarian (n=11), pesco-vegetarian (n=5) and semi-vegetarian diets (n=7).

Lysine limiting protein sources contributed the most plant protein in all diets. Methionine and non limiting protein sources were most prevalent in vegan and least prevalent in semi-vegetarian diets.

Conclusion

Vegan diets had plant protein contributions from all three clusters, while semi-vegetarian diets primarily relied on the “lysine-limiting” cluster. To improve protein quality in plant-based diets the intake of “methionine limiting”, and “no limiting” plant protein sources could be increased.