Effects of plant-based protein supplementation on hypertrophy in healthy males and females who practice resistance training: a systematic review

Efectos de la suplementación con proteína vegetal sobre la hipertrofia en hombres y mujeres con entrenamiento de fuerza: revisión sistemática

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Abstract

Introduction: In recent years, the use of plant-based diets among those who participate in resistance exercise has increased. There is little evidence that the protein requirements of vegan/vegetarian exercisers are different from those of omnivores. Vegans/vegetarians who exercise must carefully plan their diets to ensure adequate intake of essential amino acids for adequate muscle protein synthesis. This systematic review aimed to analyze the effects of plant protein isolate supplementation on skeletal muscle hypertrophy in healthy males and females engaged in resistance training.
Methods: The review used five databases and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist. Quality assessment of the reporting was performed using the CONSORT 2010 checklist. The risk of bias was assessed using the Cochrane Handbook and the ROBINS-I checklists.
Results: Initially, 1508 articles were identified. After removing duplicates (504) and reviewing titles and abstracts (1004), thirteen articles were analyzed after reading the full text. The studies varied in intervention time, training levels, use of control groups, and leucine dose standardization. Most studies used soy protein supplementation in the interventions with different daily doses. This review showed that Plant-Based Protein Supplementation, compared with whey protein or leucine consumption, in trained or untrained healthy males and females yielded similar improvements in lean mass, muscle thickness, and strength.
Conclusion: Our systematic review found that plant-based protein supplementation appears to be as effective as animal-based protein supplementation increasing lean mass, muscle thickness, and strength in healthy individuals who undergo resistance training.

Keywords

Exercise performance; healthy adults; muscle mass; plant-based protein; vegetarian diet.

Resumen

Introducción: En los últimos años, ha aumentado el uso de dietas basadas en plantas entre quienes practican ejercicios de resistencia. Existe poca evidencia de que los requerimientos proteicos de personas veganas o vegetarianas que entrenan sean diferentes de los de los omnívoros. Los veganos/vegetarianos que se ejercitan deben planificar cuidadosamente su dieta para asegurar una ingesta adecuada de aminoácidos esenciales que favorezcan una síntesis proteica muscular óptima. Esta revisión sistemática tuvo como objetivo analizar el efecto de los aislados de proteínas vegetales en forma de suplementos sobre la hipertrofia del músculo esquelético en hombres y mujeres sanos que practican entrenamiento de resistencia.
Métodos: La revisión utilizó cinco bases de datos y siguió la lista de verificación PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). La evaluación de la calidad de los informes se realizó mediante la lista de verificación CONSORT 2010. El riesgo de sesgo se evaluó mediante el Manual Cochrane y la lista de verificación ROBINS-I.
Resultados: Inicialmente, se identificaron 1508 artículos. Tras eliminar los duplicados (504) y revisar los títulos y resúmenes (1004), se analizaron 13 artículos tras la lectura completa de los textos. Los estudios variaron en cuanto al tiempo de intervención, al nivel de entrenamiento, al uso de grupos de control y a la estandarización de la dosis de leucina. La mayoría de los estudios utilizaron suplementos de proteína de soya a diferentes dosis diarias.
Conclusión: Esta revisión mostró que la suplementación con proteínas de origen vegetal, en comparación con el consumo de proteína de suero o de leucina, en hombres y mujeres sanos, entrena-dos o no, produjo resultados similares en cuanto a la mejora de la masa magra, el aumento del grosor muscular y la fuerza.

Palabras clave

Rendimiento físico; adultos sanos; masa muscular; proteína de origen vegetal; dieta vegetariana.

Introduction

In recent years, there has been an increasing adoption of plant-based diets (vegan and vegetarian) characterized by either partial or total exclusion of animal products, not only among the general public but also among those who practice resistance exercise. This change in dietary habits can be explained by a number of reasons, such as moral, religious, and cultural convictions; ethical and environmental concerns; and beliefs in health benefits (Meyer & Reguant-Closa, 2017; Dinu et al., 2017; Wirnitzer, 2020).

The eating patterns of vegetarians and vegans are diverse, given the variety of foods available to this public. According to the Academy of Nutrition and Dietetics, well-planned vegan/vegetarian diets that include vegetables, fruits, whole grains, legumes, oilseeds, nuts, and seeds are healthy and nutritionally adequate. They also help prevent and treat certain diseases and can be followed throughout life (Melina et al., 2016).

Despite the benefits of vegan/vegetarian diets, many questions remain concerning the effects of plant-based protein intake on muscle protein synthesis (MPS). Among those who participate in resistance exercise, especially those pursuing resistance training for skeletal muscle hypertrophy, the main concern is the adequacy of protein and amino acids to increase lean mass (Rogerson, 2017). It is a fact that diets usually meet the recommended protein intake when caloric intake is adequate, thus contributing to MPS (Melina et al., 2016; Rogerson, 2017; Gorissen et al., 2018).

However, the amino acid composition and essential amino acid content of dietary protein sources directly modulate increases in MPS rates (Gorissen et al., 2018).

Compared to animal-based proteins, plant-based proteins have lower anabolic properties, lower digestibility and absorption (about 10% to 15% less than those of animal sources) due to a lower essential amino acid content, and a shortage of specific amino acids, such as leucine, lysine, and/or methionine (Marsh et al., 2013; van Vliet et al., 2015).

In this context, we emphasize that there is little evidence that the protein requirements of vegans/vegetarians who engage in physical exercise differ from those of omnivores, although it is known that protein requirements should be adjusted based on the type of exercise/energy expenditure, age, sex, and body mass. However, there is growing evidence that the vegan diet needs to be well planned to provide sufficient total protein, ensure optimal essential amino acid requirements are met, and facilitate skeletal muscle hypertrophy. This happens because several essential amino acids are less abundant in plant-based diets than in omnivorous diets. That way, vegans/vegetarians who exercise should incorporate varied plant-based protein sources into their diet and/or resort to using plant-based protein isolate supplementation (Egan, 2016; Vitale & Hueglin, 2021).

Currently, plant-based protein isolates are widely available as supplements due to their greater sustainability. However, to date, there are few studies that compare the various plant protein supplements to each other (oat, wheat, microalgae, soy, rice, pea, corn, and potato) and to protein isolates of animal origin (whey, milk, caseinate, casein, and egg) (Gorissen et al., 2018). This lack of studies makes it difficult for individuals to plan their diets and choose plant-based proteins with high anabolic potential and that provide a full spectrum of essential amino acids, similar to most animal protein sources.

Emerging data support the efficacy of supplementation with plant-based protein isolates in improving performance, training recovery, and skeletal muscle hypertrophy. Furthermore, scientific evidence suggests similar responses to animal-based supplements in terms of muscle mass and strength gains (Craig & Mangels, 2009; Joy et al., 2013).

In this sense, the present systematic review aims to analyze the effect of plant-based protein isolate supplementation on skeletal muscle hypertrophy in individuals undergoing resistance training.

Method

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Page et al., 2021) and was prospectively registered with the PROSPERO database (registration number CRD42023451717). All the following steps were conducted by two independent reviewers (MAC and LCB), and inconsistencies and conflicts were resolved by a third reviewer (RLB).

Literature search strategy, inclusion and exclusion criteria, and data extraction

The literature search was conducted on August 30, 2024, and updated on December 15, 2025, in the electronic databases PubMed, Web of Science, Food Science and Technology Abstracts (FSTA), EMBASE, SPORTDiscus (EBSCO) and Scopus.

The descriptors used were selected by consulting the Medical Subject Headings (MeSH) platform (Dhammi & Kumar, 2014) The search strategy was based on PICOS (Higgins et al., 2011) using the Boolean operators "AND" and "OR" (Table 1), in view of the guiding research question: "What are the effects of plant-based protein supplementation on skeletal muscle hypertrophy in individuals undergoing resistance training?

Table 1. Description of the PICOS criteria, guiding research question and search strategy

Parameter	Description
Population (P)	Healthy adults underwent resistance training
Intervention (I)	Plant-based protein isolates supplementation
Comparator (C)	Placebo; animal protein supplementation; not use any intervention
Outcome (O)	Muscle hypertrophy assessed by DEXA, hydrostatic weighing, muscle biopsy or ultrasound
Study type (S)	Randomized Clinical Trials; Non-Randomized Clinical Trials
Guiding research question	What are the effects of plant-based protein supplementation on hypertrophy in individuals underwent resistance training?
Search strategy	('Peanut' OR 'Peanuts' OR 'Soybean' OR 'Soy Bean' OR 'Soya' OR 'Soybeans' OR 'Rice' OR 'Potato' OR 'Potatoes' OR 'Plant Protein' OR 'Grain Protein' OR 'Grain Proteins' OR 'Leaf Protein' OR 'Nut Protein' OR 'Nut Proteins' OR 'Plant Protein' OR 'Plant Proteins' OR 'Protein, Vegetable' OR 'Vegetable Protein' OR 'Vegetable Proteins' OR Pea OR 'Pisum Sativum' OR 'Peas') AND ('Resistance Training' OR 'Resistance Exercise' OR 'Resistance Exercise Training' OR 'Resistance Training' OR 'Resistance-Type Exercise' OR 'Resistance-Type Training' OR 'Strength Training' OR 'Strength-Type Exercise' OR 'Strength-Type Training' OR 'Weight Lifting' OR 'Lifting, Weight' OR 'Power Lifting' OR 'Powerlifting' OR 'Weight Lifting' OR 'Weightlifting' OR 'Weight Training' OR 'Free Weight Exercise' OR 'Weight Bearing Exercise' OR 'Weight Lifting Exercise' OR 'Weight Training' OR 'Weight-Bearing Training' OR 'Weightbearing Exercise' OR 'Weightlifting Exercise' OR 'Exercise' OR 'Effort' OR 'Exercise' OR 'Exercise Capacity' OR 'Exercise Performance' OR 'Exercise Training' OR 'Exertion' OR 'Fitness Training' OR 'Fitness Workout' OR 'Physical Conditioning, Human' OR 'Physical Effort' OR 'Physical Exercise' OR 'Physical Exertion' OR 'Physical Work-Out' OR 'Physical Workout') AND ('Skeletal Muscle Enlargement' OR 'Muscle Hypertrophy' OR 'Hypertrophia Musculorum Vera' OR 'Skeletal Muscle Hypertrophy' OR 'Skeletal Muscle' OR 'Cross Striated Muscle' OR 'Cross Striped Muscle' OR 'Muscle, Skeletal' OR 'Skeletal Muscle' OR 'Skeletal Musculature' OR 'Skeleton Muscle' OR 'Trunk Muscle')

The inclusion criteria for the studies were: 1) full-text articles; 2) studies conducted with healthy males and females; 3) intervention with plant-based protein supplementation; 4) studies that imposed resistance training during the intervention period; and 5) studies that assessed skeletal muscle hypertrophy by DEXA, hydrostatic weighing, muscle biopsy or ultrasound as the primary outcome. Exclusion criteria were: 1) duplicate articles excluded by the system and manually; 2) review articles, monographs, dissertations, theses, abstracts, or book chapters; 3) studies in which the sample was composed of animals; and 4) studies that investigated only the effects of a single acute resistance training.

Search results were exported from the databases to EndNote® reference management software version X7 (Thomson Reuters, New York, USA). After excluding duplicates and triplicates, the articles were selected based on their titles and abstracts. Then, the texts were fully read by two independent reviewers (MAC and LCB), followed by comparison. Conflicting decisions were resolved by a third reviewer (RLB).

The selected articles underwent data extraction. In addition, the reference lists of all selected studies were reviewed to identify eligible studies that might not have been located. Using a previously standardized form (Microsoft Excel®), the first two reviewers (MAC and LCB) independently extracted the following data from the studies: name and contact information of the authors, year of publication, title of the article, study design, country of data collection, participants' characteristics, sample size, details about the intervention (type of protein used in the intervention, comparison group, training program), outcome assessment methods, and main results. Discrepancies that remained after the comparison of the forms were resolved by the third reviewer (RLB).

Report assessment and methodological quality

The quality assessment of the review was performed independently by two reviewers (MAC and LCB) using the CONSORT 2010 checklist (Schulz et al., 2010) for Randomized Clinical Trials (RCTs) and the TREND checklist (Des Jarlais et al., 2004) for Non-Randomized Clinical Trials (NRCTs).

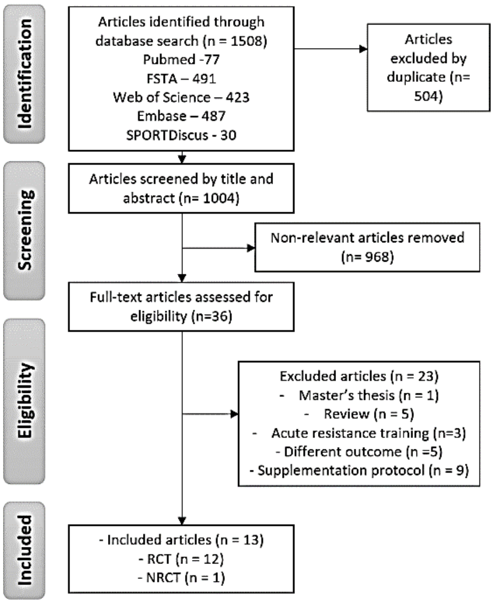
Bias risk assessment was performed independently by two reviewers (MAC and LCB) using the Cochrane Handbook checklist (Higgins et al., 2011) for RCTs and the ROBINS-I checklist (Sterne et al., 2016) for NRCTs. Graphical results were obtained using Cochrane RevMan Web (RevMan Web, 2022) and Rob-Vis Web (McGuinness & Higgins, 2021).

After individual analysis by each reviewer, the results were compared, and disagreements were discussed. Conflicting decisions were resolved by the third reviewer (RLB).

Results

The searches identified 1334 articles of potential interest, which, after the exclusion of duplicates (493) and the reading of the title and abstract (827), resulted in the selection of 16 articles. After full-text review, four additional studies were excluded for not meeting the inclusion criteria, totaling 13 articles. In the end, 13 articles were included and summarized in the present review, as shown in the flow diagram below (Figure 1)

Figure 1. Flow diagram of the systematic search for studies on the use supplementation with plant-based protein isolates for muscle mass gain in individuals undergoing resistance exercise.



Information from the included studies and a quality assessment of the reporting are summarised in Table 2.

Table 2. Characteristics of all included studies

Author (year)	Age (in years)	Study location Study design	Participants Training status, gender (sample size)	Supplementation of the intervention group Amount of protein (g)	Control group supplementation	Exercise (n times per week and duration)	Intervention Group		Control Group		Evaluation of hypertrophy	Intervention effects on hypertrophy	Quality of reporting*** (%)
							Before intervention	After intervention	Before intervention	After intervention			
Brown et al. (2004)	19 - 25*	USA Double-blind RCT	Trained, male (27)	Soy Protein Bar 33 g of	No consumption of	RT** 9 weeks	Soy Group Lean	Soy Group Lean	Lean mass	No change	Hydrostatic weighing	Lean mass increased with no	61.3

				protein/day 11 g each bar 3x/day Whey Protein Bar 33 g/day 11 g each bar 3x/day	vegetable and animal protein bar		mass 66±2.3 kg Whey Group Lean mass 67±1.96 kg	mass 68±2.3 kg Whey Group Lean mass 69±1.96 kg	67±1.65 kg			difference between the supplemented groups, but with statistical difference compared to the control	
Candow et al. (2006)	18 - 35*	Canada Double-blind RCT	Untrained, male (9) female (18)	Whey Protein 1.2 g/kg body weight + 0.3 g/kg sucrose powder Soy protein 1.2 g/kg body weight + 0.3 g/kg body weight sucralose Divided into 3 doses a day	1.2 g/kg body weight maltodextrin + 0.3 g/kg sucrose powder, divided into 3 doses per day	RT (3x a week) 6 weeks	Whey Group Lean mass (kg), squat and bench press RM graphic representation Soy Group Lean mass (kg), squat and bench press RM graphic representation	Whey Group Lean Mass + 2.5 kg Squat RM + 26.7 kg Bench press RM + 8.6 kg Soy Group Lean mass + 1.7 kg Squat RM + 23.7 kg Bench press RM + 7.6 kg	Maltodextrin + sucrose Lean mass (kg), squat and bench press RM graphic representation	Maltodextrin + sucrose Lean mass + 0.3 kg Squat RM + 14.1 kg Bench press RM + 4 kg	DEXA, squat and bench press RM	Lean mass increased and the RM test improved in both supplemented groups, with a significant difference compared to the placebo group, which had improvements over their baseline parameters.	65.6
Hartman et al. (2007)	18-30	Canada RCT	Healthy men (56)	Fat-free Milk (500 mL = 17,5g of protein) Soy Protein Drink (500 mL = 17,5g of protein)	Maltodextrin 9% (500mL)	RT 5x (week) 12 weeks	Milk FBFM 62.4kg Type II fiber CSA ~4500(µm²) Type I fiber CSA ~3800(µm²) Leg Strength (1RM) -186kg Leg press -128kg Knee extension -71kg Hamstring curl Soy Protein Drink FBFM 64.0kg Type II fiber CSA ~4700(µm²) Type I fiber CSA ~4000(µm²)	Milk FBFM 66.3kg Type II fiber CSA ~6200(µm²) Type I fiber CSA ~4900(µm²) Leg Strength (1RM) -377kg Leg press -214kg Knee extension - 115kg Hamstring curl Soy Protein Drink FBFM 66.8kg Type II fiber CSA ~5700(µm²) Type I fiber CSA ~4700(	Maltodextrin 9% FBFM 63kg Type II fiber CSA ~4700(µm²) Type I fiber CSA ~4000(µm²) Leg Strength (1RM) -210kg Leg press -122kg Knee extension -71kg Hamstring curl	Maltodextrin 9% FBFM 65.4kg Type II fiber CSA ~5300 (µm²) Type I fiber CSA ~4200 (µm²) Leg Strength (1RM) -394kg Leg press -178kg Knee extension -107kg Hamstring curl	DEXA, muscle biopsy, leg press RM test	Milk consumption resulted in greater gains in FBFM and type II muscle fiber area. Type I muscle fiber area increased after training only in the Milk and Soy groups. All groups showed increased strength as a result of the training program.	40.5

							Leg Strength (1RM) -213kg Leg press -131kg Knee extension - 78kg Hamstring curl	µm²) Leg Strength (1RM) -423kg Leg press -209kg Knee extension - 112kg Hamstring curl					
Joy et al. (2013)	21	USA Double-blind RCT	Trained, male (24)	Rice Protein 48 g/day Whey Protein (Whey Protein Isolate) 48 g/day	No placebo group	RT (3x a week) 8 weeks	Rice Protein Lean mass 58.5 kg Muscle thickness (mm) - biceps (0.36) and quadriceps (0.5) 85.9 kg Bench press RM 220 kg Leg press RM Whey Protein (Whey Protein Isolate) Lean mass 59.6 kg Muscle thickness (mm) - biceps (0.36), and quadriceps (0.48) 89.5 kg Bench press RM 209.5 kg Leg press RM	Rice Protein Lean mass 61 kg Muscle thickness (mm) - biceps (0.41) and quadriceps (0.52) 95.5 kg Bench press RM 286.8 kg Leg press RM Whey Protein (Whey Protein Isolate) Lean mass 62.8 kg Muscle thickness (mm) - biceps (0.41) and quadriceps (0.51) 98.5 kg Bench press RM 289.7 kg Leg press	---	---	DEXA, leg press RM test and bench press Ultrasonography (muscle thickness)	Increased lean mass, increased muscle thickness, improvement in the RM test with no statistical difference between the groups.	48.4
Volek et al., 2013	18-35	USA Double-blind RCT	Healthy men (56) Healthy woman (26)	Whey Protein Concentrate (WPC) 22 g/day Soy Protein Isolate (SPI) 22 g/day	Maltodextrin	RT three 12-week mesocycles 9 months	WPC Lean Body Mass 51.7 kg 52 kg bench press RM 83kg squat RM SPI	Maltodextrin Lean Body Mass 49.8 kg 45 kg bench press RM 71kg squat RM	WPC Lean Body Mass 55kg 72.1 kg bench press RM 118,8kg squat RM SPI	Maltodextrin Lean Body Mass 52.1 kg 61 kg bench press RM 114.7kg squat RM	DEXA 1 RM squat 1 RM bench press	Lean body mass significantly increased at 3 months and remained significantly higher than baseline at 6 and 9 months for all groups. There was a	51.4

							Lean Body Mass 48.5kg 45kg bench press RM 60kg squat RM		Lean Body Mass 50.3kg 60.9kg bench press RM 99.8kg squat RM			main effect of time on maximal bench press and squat strength as shown by a significant increase at 3 months that remained higher than baseline at 9 months.	
Babault et al. (2015)	18 – 35*	France Double-blind RCT	Untrained, male (161)	Pea Protein Isolate 50 g/day 25 g 2x day Whey Protein Concentrate (WPC) 50 g/day 25 g 2x/day	Maltodextrin with no added protein (quantity not informed)	RT (3x a week) 12 weeks	Pea Protein Isolate Biceps Thickness 25 mm Circumference of relaxed arm 32.3 cm Cir. Contracted Arm 33.3 cm WPC Biceps Thickness 24.3 mm Circumference of relaxed arm 31.6 cm Cir. Contracted Arm 32.4 cm	Pea Protein Isolate Biceps Thickness + 13.4% Circumference of relaxed arm 32.7 cm Cir. Contracted Arm 34.1 cm WPC Biceps thickness + 15.6% Circumference of relaxed arm c 33.1 cm Cir. Contracted Arm 33.4 cm	Maltodextrin with no added protein Biceps Thickness 25.4 mm Circumference of relaxed arm 32.0 cm Cir. Contracted Arm 32.7 cm	Maltodextrin with no added protein Biceps Thickness + 10.7% Circumference of relaxed arm c 32.4 cm Cir. Contracted Arm 33.7 cm	Ultrasound, arm circumference, and maximum strength in isokinetic conditions	There was an increase in biceps muscle thickness in both supplemented groups, but no statistical difference between the Pea Protein and Whey Protein groups. However, pea protein promoted a greater increase in muscle thickness compared to the placebo. There was an increase in the circumference of the contracted and relaxed arm between the groups, but no statistical difference between them.	78.1
Thoms on et al. (2015)	61	Australia RCT	Untrained, both (83)[1]	Dairy protein (HP-D) shake with fat-free milk and diet yogurt (27 g) + Diet 1 g/kg/day lean meat protein Soy-based protein (HP-S) Shake with low-fat soy drink + soy yogurt (27 g) + Diet 1 g/kg/day lean meat	Diet 1 g/kg/day lean meat protein (UP)	RT 3x (week) 12 weeks	HP-D Manual force 35 kg Maximum weight per 8RM 149.9 kg Lean mass 49.6 kg HP-S Manual force 34 kg Maximum weight	HP-D Manual force 36 kg Maximum weight per 8RM 280.2 kg Lean mass 50.6 kg HP-S Manual force 35.7 kg Maximum weight	UP Manual force 33 kg Maximum weight per 8RM 147 kg Lean mass 47.9 kg	UP Manual force 35.7 g Maximum weight per 8RM 273 kg Lean mass 47.9 kg	Handgrip dynamometer (manual strength), RM test for 6 exercises, and DEXA	Intake of additional protein (dairy or soy) compared to usual protein intake provided no additional benefit for improvements in strength and body composition. Additional soy protein intake also	80

				protein			per 8RM 168.6 kg Lean mass 49.4 kg	per 8RM 270.7 kg Lean mass 50.8 kg				attenuated muscle strength gains during resistance training compared to increased dairy protein intake or usual protein intake.	
Mobley et al. (2017)	21 ± 1	USA Double-blind RCT	Untrained, male (75)	Leucine 2.3 g Soy protein concentrate (SPC) 39.2 g Whey Protein Concentrate (WPC) 26.3 g Hydrolyzed Whey Protein (HWP) 25.4 g 2x day All standardized to provide 3 g leucine	Maltodextrin 2x day	RT 3x (week) 12 weeks	Leucine Lean Mass Total 36.4 kg 68 kg bench press RM 85 kg squat RM Total satellite cell 8 SPC Total Lean Mass 37.3 kg 65 kg bench press RM 82 kg squat RM Total satellite cell 9 WPC Total Lean Mass 36.3 kg 68 kg bench press RM 83 kg squat RM Total satellite cell 5 HWP Total Lean Mass 37.4 kg 73 kg bench press RM 83 kg squat RM Total satellite cell 9	Leucine Lean Mass Total 38.9 kg 82 kg bench press RM RM squat 112 kg Total satellite cell 15 SPC Total lean mass 39.9 kg 82 kg bench press RM 118 kg squat RM Total satellite cell 14 WPC Total Lean Mass 38.3 kg 82 kg bench press RM 118 kg squat RM Total satellite cell 12 HWP Total Lean Mass 39.3 kg 89 kg bench press RM 120 kg squat RM Total satellite cell 14	Maltodextrin Total lean mass 36.5 kg 66 kg bench press RM 70 kg squat RM	Maltodextrin Total lean mass 38.9 kg 79 kg bench press 111 kg squat RM	DEXA, muscle biopsy, ultrasound and Isometric Thigh Traction (IMTP), squat and bench press repetition maximum test	All supplemented groups, including the placebo, exhibited statistically similar increases in total body muscle mass. There was an effect of training on the improvement of the evaluated parameters, but the supplementation did not contribute to this improvement. Fiber type I and II. Only the WPC and HWP groups increased the number of satellite cells in the muscle.	71.9

Lamb et al. (2020)	50 - 80	USA RCT	Untrained, male (22) female (17)	Peanut protein 30.1 g/day	Unsupplemented	RT 2x (week) 6 and 10 weeks	Peanut protein Total cross-sectional area (mCSA) 109.6 cm^2 Vastus lateralis (VL) muscle thickness 1.8 cm	Peanut protein Total cross-sectional area (mCSA) 115.8 cm^2 Vastus lateralis (VL) muscle thickness 2.0 cm	Unsupplemented Total cross-sectional area (mCSA) 117.1 cm^2 Vastus lateralis (VL) muscle thickness 2.1 cm	Unsupplemented Total cross-sectional area (mCSA) 120.0 cm^2 Vastus lateralis (VL) muscle thickness 2.1 cm	DEXA, muscle biopsy, ultrasound, and isokinetic dynamometer	Significant increase in VL muscle thickness and total cross-sectional area (mCSA) in the supplemented group compared to the unsupplemented group.	74.2
Lynch et al. (2020)	18 - 35*	USA Double-blind RCT	Untrained, male (17) female (31)	Whey Protein Isolate (WPI) 19 g/day Soy Protein Isolate (SPI) 26 g/day	No placebo group	RT 3x (week) 12 weeks	WPI Lean mass 44.5 Vastus lateralis (VL) and intermedius muscle thickness (cm) 2.3 and 1.6 Peak torque extension and bending (Nm) 124.4 and 60.5 SPI Lean mass 44.1 Vastus lateralis (VL) and intermedius muscle thickness (cm) 2.2 and 1.6 Peak torque extension and bending (Nm) 132 and 64.3	WPI Lean Mass 46 Vastus lateralis (VL) and intermedius muscle thickness (cm) 2.5 and 1.6 Peak torque extension and bending (Nm) 164.6 and 80.9 SPI Lean mass 45.2 Vastus lateralis (VL) and intermedius muscle thickness (cm) 2.3 and 1.5 Peak torque extension and bending (Nm) 160.4 and 80.6	---	---	DEXA, ultrasound, and isokinetic dynamometer	Both groups significantly increased lean body mass, with no significant differences between the groups over time. There was a trend towards increased thickness of the vastus lateralis (VL) over 12 weeks, with no differences between the groups. Peak extensor and flexor torque increased in both groups, with no significant differences.	61.3
Moon et al. (2020)	32,8 ± 6,7	USA Double-blind RCT	Trained, male (24)	Rice protein 24 g Whey Protein Concentrate (WPC) 24 g	No placebo group	RT 4x (week) 8 weeks	Rice Protein Lean mass 64.7 kg Bench and leg press RM (kg) 110.8 and 331 Wingate test	Rice Protein Lean mass 65.3 kg Bench and leg press (kg) 114.9 and 355 Wingate test	---	---	DEXA, repetition maximum (RM), Wingate, and Bioimpedance tests	There were significant improvements in lean mass, RM, and power tests, but no statistical difference between the groups.	80.6

							9.7 W/kg WPC Lean Mass 63.4 kg Bench and leg press (kg) 114.4 and 315.0 Wingate test 9.5 W/kg	9.7 W/kg WPC Lean Mass 64.5 kg Bench and leg press (kg) 117 and 342 Wingate test 9.3 W/kg					
Hevía-Larraín et al. (2021)	18 - 35*	Brazil NRCT	Untrained, Vegan male (19) Omnivorous men (19)	Soy protein isolate for vegans – adjustment of 1.6 g/kg body weight/day 58 g divided 2x/day Whey Protein Concentrate (WPC) for omnivores – adjustment of 1.6 g/kg body weight/day 39 g divided 2x/day	No placebo group	RT 2x (week) 12 weeks	Soy Protein Isolate for Vegan Lean leg mass 18.1 kg Rectus femoris and vastus lateralis cross-sectional area (mCSA) 8.6 and 21.6 cm^2 258 kg leg press RM WPC Lean leg mass 19.1 kg Rectus femoris and vastus lateralis cross-sectional area (mCSA) 8.7 and 22.1 cm^2 261 kg leg press RM	Soy Protein Isolate for Vegan Lean leg mass 20.1 kg Rectus femoris and vastus lateralis cross-sectional area (mCSA) 9.6 and 23.8 cm^2 354 kg leg press RM WPC Lean leg mass 20.3 kg Rectus femoris and vastus lateralis cross-sectional area (mCSA) 9.4 and 24.9 cm^2 383 kg leg press RM	---	---	DEXA, ultrasound, muscle biopsy, and repetition maximum (RM) test	Increased muscle mass, muscle thickness, and improvement in the RM test in both groups, with no significant difference between them.	80
Santini et. al. (2025)	18-35*	Brazil Double-blind RCT	Untrained, male (44)	Plant Protein Blend (soy and pea) 45g $^{d-1}$ divided 3x/day (15g) Whey Protein (WP) 45g $^{d-1}$ divided 3x/day	No placebo group	RT 3x (week) 12 weeks	Plant Protein Blend Whole-body lean mass 50.21 kg Appendicular lean mass	Plant Protein Blend Whole-body lean mass 52.62 kg Appendicular lean mass	---	---	DEXA, ultrasound, muscle, and repetition maximum (RM) test	Increased whole-body, leg, appendicular lean mass, lean mass, vastus lateralis mCSA and improvement in the RM test-leg press in both	

	(15g)	23.33 kg Leg Lean Mass 17.38 kg mCSA 25.36 cm^2 215kg leg-press (1RM)	24.52 kg Leg Lean Mass 18.26 kg mCSA 28.53 cm^2 279kg leg-press (1RM)	groups, with no significant difference between them.
		WP Whole-body lean mass 49.08 kg Appendicular lean mass 22.37 kg Leg Lean Mass 16.52 kg mCSA 24.65 cm^2 197kg leg-press (1RM)	WP Whole-body lean mass 52.31 kg Appendicular lean mass 24.16 kg Leg Lean Mass 17.80 kg mCSA 27.90 cm^2 255kg leg-press (1RM)	

Note. Intervention Group - Plant-based protein and animal protein supplementation; Control Group – Placebo or not use any intervention; RCT - Randomized Clinical Trials; NRCT - Non-Randomized Clinical Trials; SD (±) - standard deviation; USA - United States of America; WPC - whey protein concentrate; WPI - whey protein isolate (WPI); SPI -soy Protein Isolate ; HP-S - soy-based protein; HWP - whey protein hydrolyzed; UP – usual protein; VL - Vastus lateralis ; RT - resistance training; DEXA - dual-energy X-ray absorptiometry; RM testing: maximum repetition test; CSA - cross-sectional area; mCSA - muscle cross-sectional area; Nm- Newton-meters; IMTP testing: isometric mid-thigh pull testing; FBFM : fat and bone-free mass; mCSA: Muscle cross sectional área; *Minimum and maximum age, in years; **Study did not specify weekly frequency; *** CONSORT 2010 checklist for RCT and the TREND checklist for NRCT; [1] there is no specification of the number of men and women participating.

The oldest article was published in 2004, while the most recent one was published in 2025. The studies included individuals aged 18 to 68 years, totalling 590 participants, with eight studies recruiting only men (Joy et al., 2013; Brown et al., 2004; Hartman et al., 2007; Babault et al., 2015; Mobley et al., 2017; Moon et al., 2020; Hevia-Larraín et al., 2021; Santini et al., 2025) and five including both men and women. Most studies were conducted in North America (n = 9), with others in South America (n = 2), Europe (n = 1), and Oceania (n = 1). Regarding the training status of the participants, three studies had trained individuals as participants (Joy et al., 2013; Brown et al., 2004; Hartman et al., 2007; Babault et al., 2015; Mobley et al., 2017; Moon et al., 2020), and ten studies had untrained individuals.

The quality assessment of reports recommended by CONSORT (Schulz et al., 2010) and TREND (Des Jarlais et al., 2004) checklists showed that the included articles met 40.5% [22] to 88% [26] of the recommended items. Among the RCTs, none of the studies reported "Defining recruitment dates and follow-up periods" and only one (Santini et al., 2025) met "Methods for further analyses, such as subgroup analyzes and adjusted analyses". The NRCT, on the other hand, did not present a discussion of research, pro-grammatic, or policy implications.

Characteristics of intervention/control group supplementation, dosage, intervention duration, and training frequency

Of the 13 included studies, 12 are RCTs and one is an NRCT (Hevia-Larraín et al., 2021). One study compared vegans and omnivores (Hevia-Larraín et al., 2021), while the other studies conducted the intervention only with omnivores. Regarding the plant-based protein and the doses used in interventions, we found that eight studies used soy protein supplementation at doses ranging from 17.5 g to 39 g/day (Joy et al., 2013; Hartman et al., 2007; Mobley et al., 2017; Hevia-Larraín et al., 2021; Mobley et al., 2017; Thomson et al., 2016; Lynch et al., 2020) two studies used rice protein at 24 g/day and 8 g/day (Joy et al., 2013; Moon et al., 2020) one study used pea protein at 50 g/day (Babault et al., 2015), one study used peanut protein at 30 g/day (Lamb et al., 2020) and one study used protein blend (pea and soy) at 45 g/day (Santini et al, 2025).

Regarding animal protein supplementation, 11 studies used whey protein (concentrate, isolate and hydrolysate) as a second intervention group (Joy et al., 2013, Brown et al., 2004; Babault et al., 2015; Mobley et al., 2017; Moon et al., 2020; Hevia-Larraín et al., 2021; Candow et al., 2006; Volek et al., 2013; Thomson et al., 2016; Lynch et al., 2020; Santini et al, 2025). Hartman et al. (2007) used fat-free milk in the intervention. Thomson et al. (2016) used milk and yogurt as animal protein in the intervention. Lamb et al. (2020) were the only authors who did not use animal protein in the interventions.

Six studies used whey protein, with doses ranging from 19 g/day to 50 g/day (Joy et al., 2013; Brown et al., 2004; Volek et al., 2013; Thomson et al., 2016; Lynch et al., 2020; Santini et al., 2025). Hartman et al. (2007) used fat-free milk at 17,5g/day. Thomson et al. (2016) used a protein shake based on fat-free milk and diet yogurt, at 27 g/day. Mobley et al. (2017) used concentrated soy protein and leucine, in addition to whey protein concentrate (WPC) and hydrolyzed whey protein (HWP), all at sufficient levels to provide 3 g of leucine. Lamb et al. (2020) used only peanut protein, providing 30.1 g of protein in the supplemented dose.

Regarding the supplementation used in the control groups, five studies used maltodextrin (Hartman et al., 2007; Mobley et al., 2017; Candow et al., 2006; Volek et al., 2013) while three others (Mobley et al., 2017; Thomson et al., 2016; Lamb et al., 2020) did not use any dietary supplements or make dietary changes to the participants.

The other studies did not have a control group; they had only two or more intervention groups, which were compared to each other.

Regarding participants' protein intake, only three studies control or adjust the protein recommendation (Joy et al., 2013; Hevia-Larraín et al., 2021; Volek et al., 2013), whereas the other studies maintain regular dietary habits.

All studies used a resistance training program lasting 6 to 12 weeks, except one, which lasted 9 months (Hartman et al., 2007). The frequency of resistance training across studies ranged from 2 to 4 times per week, and only Brown et al. (2004) and Hartman et al. (2007) did not report participants’ training frequency.

As described in Table 2, we observe that the plant-based protein used, intervention time, training level, participants’ sex, the (non)use of control groups (if so, different substances were used), and even the (non) standardization of the leucine dose varied across the studies.

Protein standardization of supplements and diet

Mobley et al. (2017), Lamb et al. (2020), and Lynch et al. (2020) were the only researchers who equalizezed leucine supplementation to 3 g, 2.4 g, and 2 g/day, respectively.

Regarding dietary control, four studies-controlled participants' diets, guiding or planning them in an individualized manner (Joy et al., 2013; Moon et al., 2020; Hevia-Larraín et al., 2021). The other studies requested a 3- or 4-day food record for monitoring purposes but recommended that participants maintain their eating habits without any changes (Brown et al., 2004; Babault et al., 2015; Mobley et al., 2017; Candow et al., 2006; Thomson et al., 2016; Santini et al., 2025).

Intervention effects on skeletal muscle hypertrophy, strength and body composition.

Among the included articles, eight used soy protein supplementations in different forms and doses versus whey protein concentrate/isolate, fat-free milk, and dairy protein (HP-D) shake, showed a positive effect on skeletal muscle hypertrophy measures (Brown et al., 2004; Hartman et al., 2007; Mobley et al., 2017; Hevia-Larraín et al., 2021; Lynch et al., 2020).

This effect was observed in two studies, in which hypertrophy-related parameters improved in both the supplemented and control groups (Mobley et al., 2017; Thomson et al., 2016). In both studies, the training period was the same, and the sample consisted of untrained individuals. However, the study by Thomson et al. (2016) included elderly men and women, whereas Mobley et al.'s (2017) included adult men. The number of supplemented groups, the type of supplementation, and the control groups varied across these studies. While Thomson et al. (2016) kept the participants' usual diet as the control group, Mobley et al. (2017) used maltodextrin for comparison purposes with the supplemented groups. Another difference observed was the form of the supplements: shakes and powders. Therefore, the similar results obtained by these authors across different contexts and effect sizes of resistance training on skeletal muscle hypertrophy measures are consistent with previous data (Lim et al., 2022).

Three selected studies used trained individuals in the sample, but with different supplementation protocols (soy and rice protein, maltodextrin). In the study by Brown et al. (2004), participants were divided into three groups. One group consumed soy protein bars, another consumed whey protein bars at the same doses, and a third group underwent the training protocol without supplementation. Training effects on lean mass increase were observed in all three groups, with significant differences observed only between the supplemented and control groups.

Joy et al. (2013) and Moon et al. (2020) investigated the use of rice protein. Joy et al. (2013) pioneered supplementation with rice protein rather than whey protein, evaluating skeletal muscle hypertrophy by changes in body composition and muscle thickness (biceps and quadriceps) after participants underwent resistance training. Participants received individualized diet plans and supplementation (48 g of rice protein or whey protein concentrate [WPC]). At the end of the program, training improved lean mass and decreased body fat, and increased biceps and quadriceps thickness in both groups, with no significant difference between them. Moon et al. (2020) used 24 g of whey protein or rice protein to assess body composition parameters and strength evolution. There were improvements in all three, with no significant difference between groups. There was no dietary calculation in the study, but food recalls were conducted every 2 weeks throughout the study, and the average protein consumption among participants was 1.8 g/kg/day, indicating a high-protein diet.

Thus, according to Joy et al. (2013) and Moon et al. (2020), rice protein can be used to promote skeletal muscle hypertrophy in trained or untrained adult men, as it has been shown to improve lean mass and strength outcomes comparable to whey protein.

On the other hand, Hartman et al. (2007) conducted a study comparing the consumption of fat-free milk with soy protein and maltodextrin in young trained men who engaged in resistance training 5 days a week for 12 weeks. Supplementation was consumed immediately after and 1 hour after exercise. No differences in maximum strength were observed among the groups; all groups showed improvement in this parameter. Regarding body composition, increases in lean mass and decreases in body fat were observed in all groups, with a significant difference in the fat-free milk group compared with the soy protein and carbohydrate group. Type 1 fibers increased only in the groups that consumed soy and milk, with a significant difference observed only between the milk group and the carbohydrate group. Type 2 fibers exhibited different behavior, increasing in all groups (indicating a training effect), with a significant increase in the milk group compared with the soy and carbohydrate groups.

Santini et al. (2025), evaluated the effects of a protein blend (pea + soy) compared with whey protein on parameters related to strength training adaptations. In this study, 44 untrained men underwent 12 weeks of strength training, consuming 1.6 g/kg/day of protein, with supplementation provided as whey protein or a protein blend, distributed in 3 daily doses of 15 g each (totaling 45 g/day). At the beginning and end of the study, strength was assessed using the 1RM test, muscle cross-sectional area of the vastus lateralis was measured, and body composition was evaluated using DXA. Both groups showed increases in muscle mass and strength after the training period, with no significant difference between them, indicating that consuming a plant protein blend (two different amino acid profiles) is equivalent to whey protein in promoting muscle hypertrophy.

Therefore, in studies evaluating trained individuals, results are conflicting regarding lean mass increases. Only one study assessed the impact of plant-based protein supplementation in this population.

Candow et al. (2006) and Lynch et al. (2020) studied untrained adult men and women and obtained similar results: increased lean mass and improved strength, even with different intervention durations. Participants in the Candow et al. (2006) study were instructed to follow a meat-free diet for 72 hours prior to the start of training, and a 3-day recall was conducted in the first and last weeks of training to account for protein consumed between groups during the study. Supplementation consisted of soy protein, whey protein, or placebo (maltodextrin) at equal doses, 3 times a day. Protein intake in the supplemented group was higher than in the placebo group, with supplementation alone accounting for 1.2 g/kg/day. Regarding skeletal muscle hypertrophy measures, increases in lean mass and improvements in the 1RM test were observed in all three groups, characterizing the training effect once again; however, there was a significant difference between the placebo group and the supplemented groups, with no difference between the supplemented groups.

Although there was concern about protein control in the study by Candow et al. (2006), the leucine dose was not standardized across the supplemented groups. This standardization can be seen in Lynch et al.'s (2020) study, which compared soy vs whey protein at different doses (both with 2 g of leucine). Both groups showed significant increases in lean mass and strength (training effect), with no significant difference between them. Thus, in the two studies conducted with untrained adults of both sexes, lean mass increased, and strength improved in all supplemented groups, regardless of protein source.

The amount of consumed leucine appears to play a crucial role in lean mass increase and hypertrophy parameters, especially over longer periods. In the study by Volek et al. (2013), young, untrained men participated in a supervised resistance-training program involving full-body exercises for 9 months. They used supplementation with whey protein, isolated soy protein, or carbohydrates. Nutritional guidance was provided, and although the diet was not precisely calculated, participants were advised to consume sufficient energy to prevent weight loss and to maintain protein intake between 1 and 1.2g/kg/day (excluding supplementation). Lean mass increased in the whey protein group as early as 3 months and remained elevated through 9 months. There was no significant difference between the groups supplemented with carbohydrates or soy protein. For this reason, the authors argue that increased protein consumption alone may not directly improve lean mass and emphasize the importance of protein quality in this context. Whey protein, which has a higher concentration of branched-chain amino acids, especially leucine, is considered of higher quality and may be crucial for lean mass response. However, the authors also observed that the increase in lean mass among individuals using whey protein did not translate into increased strength.

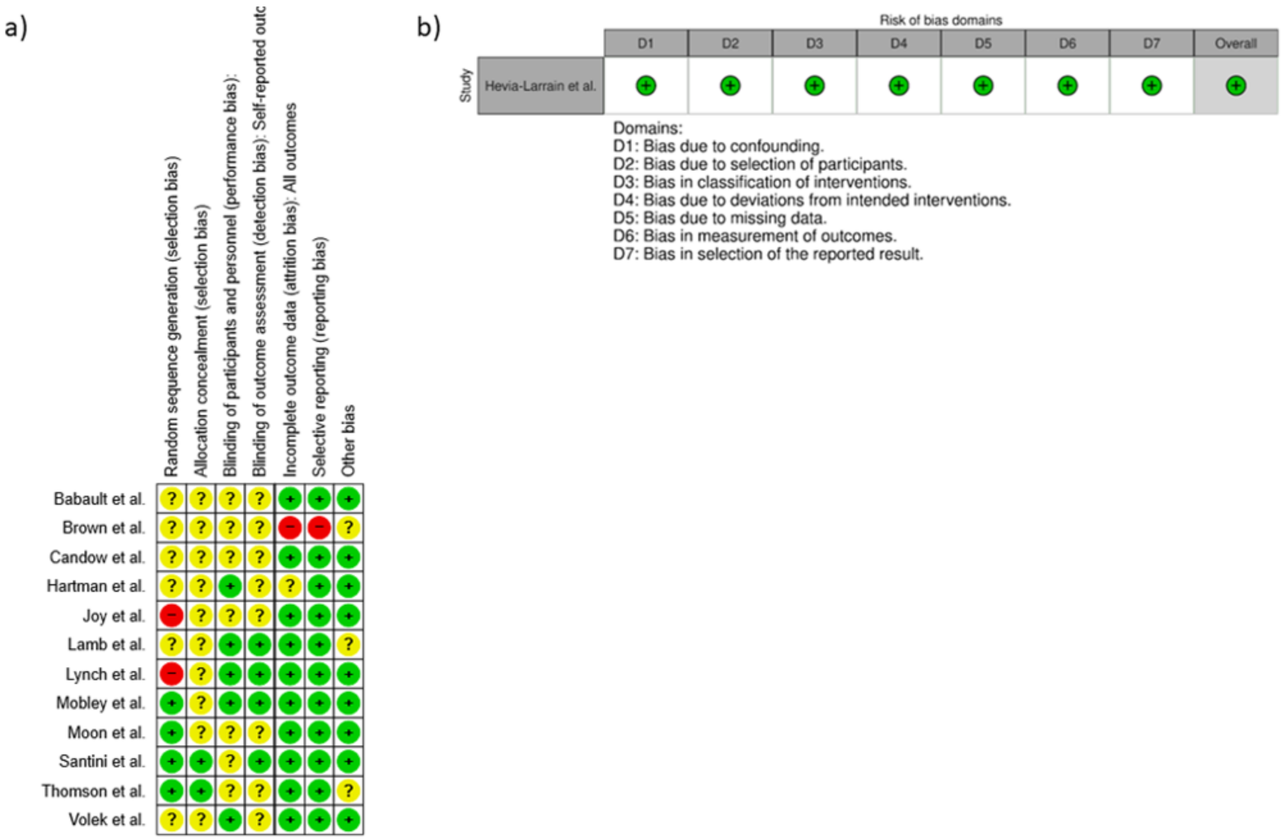
Hevía-Larrain et al. (2021) used a different methodology than the other studies included in this review. Their sample consisted of two groups of untrained men: one group consumed soy protein, and the other consumed whey protein concentrate (WPC). The soy protein group consisted of vegan individuals, and the whey protein concentrate group consisted of omnivorous individuals. The amount of supplementation was individualized so that each participant reached 1.6 g protein/kg/day, with vegan individuals receiving all dietary and supplemental protein from plant sources, while omnivorous individuals could consume both animal and plant proteins. After the training program, increased muscle mass and muscle thickness and improved strength (1RM test) were observed in both groups, with no significant difference between them.

Assessment of risk of bias and of the appropriateness of study reports according to reporting guidelines

The summaries of risk of bias from two different tools are presented in Figure 2 and were appropriate for each study design. All RCTs were deemed to be at low or unclear risk of allocation concealment, blinding, and other biases. The NRCT was classified as presenting a low overall risk of bias.

CONSORT and TREND checklists were applied to assess the appropriateness of study reports according to the relevant guidelines, and the percentages of agreement are shown in the last column of Table 2. Accor-ding to the CONSORT checklist (Schulz et al., 2010), the included RCTs met 48.4-80.6% of the applicable requirements (Joy et al., 2013; Moon et al., 2020). On the other hand, according to the TREND checklist (Des Jarlais et al., 2004), the NRCT met 80% of the applicable requirements. The analysis of the items, based on the tools used, is detailed in supplementary material (S1).

Figure 2. The Cochrane Collaboration tool; b) the ROBINS-I tool.



a)

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias):	Blinding of outcome assessment (detection bias): Self-reported outc	Incomplete outcome data (attrition bias): All outcomes	Selective reporting (reporting bias)	Other bias
Babault et al.	?	?	?	?	+	+	+
Brown et al.	?	?	?	?	−	−	?
Candow et al.	?	?	?	?	+	+	+
Hartman et al.	?	?	+	?	?	+	+
Joy et al.	−	?	?	?	+	+	+
Lamb et al.	?	?	+	+	+	+	?
Lynch et al.	−	?	+	+	+	+	+
Mobley et al.	+	?	+	+	+	+	+
Moon et al.	+	?	?	?	+	+	+
Santini et al.	+	+	?	+	+	+	+
Thomson et al.	+	+	?	?	+	+	?
Volek et al.	?	?	+	?	+	+	+

b)

Risk of bias domains

Study	D1	D2	D3	D4	D5	D6	D7	Overall
Hevia-Larrain et al.	+	+	+	+	+	+	+	+

Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

Note: (+) Low risk (−) High risk (?) Unclear risk.

Discussion

This systematic review aimed to evaluate the effects of plant-based protein supplementation on hypertrophy parameters in individuals undergoing resistance training. In summary, the review found that plant-based protein supplementation is as effective as animal protein supplementation and can increase lean mass, muscle thickness, and strength in healthy individuals who practice strength training.

Strength training improves strength, power, endurance, and muscle hypertrophy, all of which are important for maintaining skeletal muscle health, particularly over the long term (Currier et al., 2026). Muscle protein synthesis (MPS) is typically assessed in the short term as an auxiliary tool for understanding the mechanisms underlying these gains (Tidball et al., 2014). Muscle sensitivity to amino acids remains elevated for up to 24 hours after exercise, so distributing protein intake throughout the day ensures an adequate supply of essential amino acids. Thus, protein intake tailored to individual needs is decisive for muscle hypertrophy (Murach et al., 2021; Slater et al., 2019; Phillips et al., 2009).

All body proteins, especially muscle proteins, are in constant turnover. In adults, this balance tends to be maintained; however, physical activity and dietary composition can alter amino acid balance, favoring protein synthesis (Devries & Phillips, 2015; Bos et al., 2003). This may explain the combination of protein supplementation and resistance training observed in the studies analyzed.

The absence of statistically significant differences in results between individuals who used vegetable or animal proteins, observed in most studies, can be explained by similarities in amino acid profiles, as well as by differences in digestibility and absorption kinetics.

Both the quantity and the quality of protein influence the gain and maintenance of muscle mass. Protein quality is related to its digestibility, essential amino acid content, and availability to support metabolic function (FAO/WHO/UNU, 2007). Plant-based proteins are directly oxidized and have higher splanchnic nitrogen retention, but they contain lower amounts of essential amino acids, especially leucine (Van

Vliet et al., 2015; FAO, 2013). The best-known indices for assessing protein quality are the Protein Digestibility Corrected Amino Acid Score (PDCAAS) and the Digestible Indispensable Amino Acid Score (DIAAS). Both consider the necessary amounts of nitrogen and amino acids to prevent nutrient deficiencies (Tang et al., 2009; Schoenfeld et al., 2019). Although the PDCAAS values of soybeans, meat, and whey protein are close (0.9, 0.92, and 1, respectively), the MPS rates differ among them (Van Vliet et al., 2015). The postprandial MPS of meat protein, as well as the acute post-exercise MPS of whey protein, are superior to an isonitrogenous dose of soy protein (Devries & Phillips, 2015; Messina et al., 2018). In this context, using higher doses of vegetable protein or protein blends tends to balance the amino acid profile of vegetable proteins relative to animal proteins and promote hypertrophy when associated with strength training (Santini et al., 2025).

Thus, the question of the use of plant-based proteins in sports, especially for muscle hypertrophy, remains. The articles included in this review showed that different vegetable proteins (soy, rice, peas, and peanuts) had positive effects on muscle hypertrophy measures when supplementation was accompanied by resistance training. Other plant proteins, such as potato protein (Banaszek et al., 2019), wheat protein (Gorissen et al., 2018), and a fungus-derived protein (Oikawa et al., 2020), also proved efficient at improving MPS. According to the studies analysed in this review, most studies involving the use of soy protein, (in various forms of presentation), rice protein, pea protein and protein blend (rice + pea), comparing them with whey protein or leucine consumption, in adult and elderly individuals of both sexes, trained or untrained, omnivores or vegans, yielded similar results in terms of improving lean mass, increasing muscle thickness, and strength.

Among the eight studies analyzed with soy protein (various forms of presentation) (Brown et al., 2004; Hartman et al., 2007; Mobley et al., 201; Hevia-Larraín et al., 2021; Candow et al., 2006; Volek et al., 2013; Thomson et al., 2016; Lynch et al., 2020), only two (Candow et al., 2006; Volek et al., 2013) demonstrated a significant improvement in parameters related to skeletal muscle hypertrophy with the consumption of animal proteins alone. Nevertheless, data suggest that soy protein is as effective as whey protein in promoting skeletal muscle hypertrophy when resistance training is performed.

These findings align with a meta-analysis by Messina et al. (2018), which showed that supplementation with soy or whey protein provides similar benefits in terms of strength gains and lean mass improvements in response to resistance exercise. The relationship between other sources of plant-based proteins and their impact on hypertrophy was also analyzed in this review. Therefore, the interpretation of the results must consider the heterogeneity of the methodologies involved.

Conclusions

In summary, this systematic review found that plant-based protein supplementation appears to be as effective as animal-based protein supplementation for increasing lean mass, muscle thickness, and strength in healthy individuals who engage in resistance training. Therefore, both athletes and physically active individuals who choose plant-based protein supplementation can achieve comparable results in muscle hypertrophy.

This review presents strengths and limitations that should be considered. Despite the great diversity of anabolic properties of plant-based proteins, their anabolic properties have been studied in only a few sources (soy, rice, peas, and peanuts). Thus, interpretations of the results must be made in light of these limitations.

Another limitation was the lack of clarity regarding participants' dietary protein intake, as in most studies, the diet was not standardized. Only three studies controlled or adjusted the protein recommendation, while the other studies maintained habitual consumption, and the lack of protein standardization may have influenced the results reported in some studies.

Strengths of this review include the number of databases investigated (five) to identify more evidence related to the theme, and the fact that this review was conducted following the PRISMA checklist. However, we emphasize that these findings should be interpreted carefully due to the unclear risk of bias in some included studies. Authors should write reports as clearly as possible, allowing for the proper communication of all procedures and choices.

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