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THE EFFECT OF PROTEIN SOURCES ON MUSCLE MASS AND RECOVERY TIME IN ATHLETES: A COMPARISON BETWEEN PROTEIN SUPPLEMENTS AND NATURAL FOODS (LITERATURE REVIEW)

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Abstract
This study aims to examine the effect of protein sources on muscle mass gain and recovery time in athletes by comparing protein supplements and protein derived from natural foods. The underlying issue of this study is the limited availability of comprehensive research that directly compares the effectiveness of these two protein sources within the context of sports nutrition. The method used is a literature review, involving the search of scientific articles through Google Scholar, PubMed, Scopus, and ScienceDirect databases, using the PICOS framework as the basis for article selection. A total of 10 research articles consisting of systematic reviews, meta-analyses, randomized controlled trials, and observational studies were analyzed descriptively and synthesized.The findings indicate that protein intake, whether from supplements or natural foods, has a positive effect on increasing muscle mass and accelerating athlete recovery, particularly when combined with resistance training. Optimal protein requirements generally range from 1.6–2.0 g/kg body weight per day, and protein effectiveness is more strongly influenced by adequate dosage and amino acid quality, especially leucine content, rather than the protein source itself. It is concluded that both protein supplements and natural foods are equally effective in supporting muscle adaptation and athlete recovery; therefore, the choice of protein source should be tailored to individual needs, training context, and food availability.

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INTRODUCTION

Protein is one of the main nutritional components that plays a crucial role in supporting muscle mass gains and the recovery process in athletes. Adequate protein intake is required to promote muscle protein synthesis, repair tissues that experience microtrauma due to exercise, and support physiological adaptations to

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high training loads (Phillips & Van Loon, 2011; Thomas et al., 2016). Therefore, strategies to meet protein requirements are a critical aspect of sports nutrition.

Numerous studies indicate that increased protein intake, particularly when combined with resistance training, contributes significantly to gains in fat-free mass and muscle strength (Morton et al., 2018; Nunes et al., 2022). Protein supplements, especially whey protein, are widely used by athletes due to their high leucine content and rapid absorption rate, making them effective in stimulating muscle protein synthesis after exercise (Tang et al., 2009; Naclerio & Seijo, 2019). However, protein from natural food sources such as meat, fish, eggs, and dairy products also provides high-quality protein along with micronutrients and bioactive compounds that play a role in muscle tissue recovery (van Vliet et al., 2015; Pearson et al., 2023).

Despite the well-documented benefits of protein, direct comparisons between protein supplements and natural food sources remain limited. Most studies compare protein supplementation with a placebo or low-protein diets rather than with natural foods matched for protein and energy content (Morton et al., 2018). In addition, research findings suggest that protein effectiveness is more strongly influenced by total daily intake adequacy and amino acid quality than by the protein source itself, with optimal athlete requirements generally ranging from 1.6–2.0 g/kg body weight per day (Nunes et al., 2022; Witard et al., 2025). Several studies even demonstrate that plant-based proteins or proteins from whole foods can produce effects comparable to whey protein when consumed in sufficient doses and combined with resistance training (Sharp et al., 2018; Singh et al., 2024).

Based on these gaps, this article offers novelty through a comparative review of protein sources by positioning protein supplements and natural foods as equally viable nutritional strategies for supporting muscle adaptation and athlete recovery. The purpose of this article is to review and synthesize scientific evidence regarding the effects of protein sources on muscle mass gains and

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recovery time in athletes. The findings of this review are expected to provide scientific contributions and practical recommendations for athletes, coaches, and sports practitioners in determining effective, evidence-based protein intake strategies.

METHOD

This study employed a literature review design with a descriptive approach, aiming to examine and synthesize findings from previous studies related to the effects of protein sources on muscle mass and recovery time in athletes. This method was chosen because it allows researchers to integrate various relevant scientific findings in order to obtain a comprehensive understanding of the topic under investigation.

The study was conducted through an online search of scientific literature without involving any specific physical location. Data collection was carried out in 2025 by accessing several credible scientific journal databases, including Google Scholar, PubMed, Scopus, ScienceDirect, and ResearchGate. The literature search focused on articles published between 2015 and 2025 to ensure the currency and relevance of the data.

The population of this study comprised all scientific articles discussing protein sources, muscle mass, and recovery time within the context of physical activity or sports. The study sample consisted of journal articles selected based on predefined inclusion and exclusion criteria. Inclusion criteria included research articles written in Indonesian or English, involving human subjects (athletes or physically active individuals), addressing protein from supplements and/or natural food sources, and reporting outcomes related to muscle mass and/or post-exercise recovery. Exclusion criteria included articles not available in full-text form, studies conducted on animals or in vitro, and articles that were not relevant to the research objectives.

The sampling technique used was purposive sampling, in which articles were deliberately selected based on their relevance to the research topic and objectives. The article selection process was conducted in stages, beginning with

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title and abstract screening, followed by full-text review. The PICOS framework (Population, Intervention, Comparison, Outcome, and Study Design) was used as a reference for the selection and categorization of articles.

Data measurement in this study was performed through data extraction from each selected article. The extracted data included the authors' names, year of publication, study design, research subjects, type of protein source, and key findings related to muscle mass and recovery time. These data were then organized into synthesis tables to facilitate comparison across studies.

Data analysis was conducted using a descriptive-narrative approach, by comparing similarities and differences in findings across the analyzed articles. The results were synthesized based on protein source categories and research outcomes, and then interpreted to draw comprehensive conclusions. No primary statistical tests were applied, as this study was a literature-based review; instead, the analysis focused on the strength and consistency of scientific evidence reported in previous research.

RESULT AND DISCUSSION

The results of this study were obtained through a systematic selection and synthesis of scientific articles relevant to protein sources, muscle mass, and athlete recovery. Based on the literature search process and the application of predefined inclusion and exclusion criteria, a total of 10 research articles were identified and analyzed systematically. These articles comprised systematic reviews, meta-analyses, randomized controlled trials (RCTs), and observational studies, with research subjects including athletes and physically active individuals.

Overall, the synthesized findings indicate that protein intake has a positive effect on increasing muscle mass and accelerating recovery time in athletes, regardless of whether the protein is derived from supplements or natural food sources. Most studies reported improvements in lean body mass and muscle strength, as well as reductions in markers of exercise-induced muscle damage, particularly when protein intake was combined with resistance training.

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Table 1. Synthesis of Studies on Protein Sources, Muscle Mass, and Recovery

No.	Authors (Year)	Study Title	Study Design / Methodology	Main Findings
1	Morton et al. (2018)	A Systematic Review, Meta-Analysis and Meta-Regression of the Effect of Protein Supplementation on Resistance Training–Induced Gains in Muscle Mass and Strength in Healthy Adults	Systematic review and meta-analysis of 49 RCTs (n = 1,863) involving ≥6 weeks of resistance training	Protein supplementation significantly increased lean body mass, muscle size, and strength. Optimal effects were observed up to ~1.6 g/kg body weight/day; higher intakes did not provide additional benefits.
2	Naclerio & Seijo (2019)	Whey Protein Supplementation and Muscle Mass: Current Perspectives	Narrative review of human intervention studies	Whey protein effectively increases muscle mass in trained individuals, mainly due to its high leucine content. Benefits diminish when daily protein intake is already ≥1.6 g/kg body weight.
3	Jahan-Mihan et al.	Current Perspectives on Protein Supplementation in Athletes: General Guidance and Special Considerations for Diabetes	Narrative review (PubMed, Scopus, SPORTDiscus; up to 2025)	Protein supplementation improves lean mass and recovery when baseline intake is inadequate. Whey protein shows superior kinetics, but plant-based proteins can be equally effective when dose and leucine content are sufficient.
4	Witard et al. (2025)	Protein Nutrition for Endurance Athletes: A Metabolic Focus on Promoting Recovery and Training Adaptation	Narrative review based on metabolic studies (amino acid oxidation indicators)	Endurance athletes require ~1.8 g/kg body weight/day, increasing to >2.0 g/kg during intense training or energy deficit. Protein supports recovery and metabolic adaptation.
5	Permadi & Alist (2025)	Relationship Between Muscle Mass, Energy and Protein Intake, and Lower Limb Strength in Soccer Athletes	Observational analytic cross-sectional study (n = 25 athletes); 2×24 h food recall, BIA, vertical jump test	Significant positive relationships were found between muscle mass, energy intake, protein intake, and lower limb muscle strength in soccer athletes.
6	Franzke	Protein Intake,	Scoping review of	Protein intake of 1.0–1.9

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	et al. (2025)	Physical Performance and Body Composition in Master Athletes—A Short Scoping Review	12 observational and intervention studies in master athletes	g/kg body weight/day was generally associated with better muscle mass and physical function, although evidence remains limited and heterogeneous.
7	Zhao et al. (2024)	The Effect of Protein Intake on Athletic Performance: A Systematic Review and Meta-Analysis	Systematic review and meta-analysis of 28 RCTs (373 athletes)	Protein intake provided small performance benefits, significant for endurance outcomes, especially when combined with carbohydrates; effects were not significant when protein was consumed alone at high levels.
8	Singh et al. (2024)	Efficacy of Pea Protein Supplementation with Resistance Training	Parallel RCT (84 days) in sedentary adults; pea protein vs whey protein	Pea protein significantly increased muscle strength and mass and was comparable to whey protein when combined with resistance training.
9	Sharp et al. (2018)	The Effects of Beef, Chicken, or Whey Protein After Workout on Body Composition and Muscle Performance	Double-blind RCT (8 weeks); four groups (whey, beef, chicken, control)	All protein sources significantly increased lean body mass and strength and reduced body fat compared with the control group.
10	Nunes et al. (2022)	Systematic Review and Meta-Analysis of Protein Intake to Support Muscle Mass and Function	Meta-analysis of 74 RCTs in healthy adults	Higher protein intake improved lean body mass and muscle strength, particularly when combined with resistance training, with the greatest effects observed at ≥1.6 g/kg body weight/day.

Discussion

This discussion comprehensively highlights the role of protein sources in promoting muscle mass gains and recovery in athletes by examining scientific evidence derived from multiple study designs. Based on the synthesis of ten

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selected articles, it can be firmly established that protein is a key nutritional component in supporting physiological adaptations to exercise, particularly resistance training, both in terms of muscle hypertrophy and accelerated recovery processes.

Effect of Protein Intake on Muscle Mass Gains

Evidence from meta-analyses and systematic reviews consistently demonstrates that increased protein intake significantly contributes to gains in lean body mass and muscle strength, especially when combined with structured resistance training. Morton et al. (2018) reported that protein supplementation produces consistent positive effects on muscle hypertrophy, with an optimal intake threshold of approximately 1.6 g/kg body weight per day. This finding reinforces the notion that total daily protein adequacy is more influential than the specific form or source of protein consumed.

Protein supplements, particularly whey protein, are frequently reported to be superior in stimulating muscle protein synthesis due to their high leucine content and rapid absorption rate. Leucine serves as a primary trigger for activation of the mammalian target of rapamycin (mTOR) pathway, a key molecular mechanism underlying muscle hypertrophy. However, this advantage becomes less pronounced in athletes or individuals who already meet their daily protein requirements through a balanced diet, as demonstrated by Naclerio and Seijo (2019).

Effect of Protein Intake on Athlete Recovery

Beyond its role in hypertrophy, protein plays a critical role in the muscle recovery process. High-intensity exercise induces microtrauma to muscle fibers, which requires repair through muscle protein synthesis. Adequate protein intake has been shown to reduce markers of muscle damage, accelerate strength recovery, and alleviate post-exercise muscle soreness.

Witard et al. (2025) reported that protein requirements may increase to >2.0 g/kg body weight per day in athletes, particularly endurance athletes or those experiencing energy deficits, to support recovery and metabolic adaptation. These

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findings underscore that protein requirements are dynamic and influenced by sport type, training intensity, and the athlete's physiological condition.

In this context, whole foods offer distinct advantages by providing a broad spectrum of nutrients that support recovery in a holistic manner. The presence of carbohydrates, vitamins, and minerals in natural foods contributes to glycogen replenishment, immune function, and inflammation regulation, thereby indirectly enhancing muscle recovery.

Comparison Between Protein Supplements and Whole-Food Protein

The comparison between protein supplements and protein derived from whole foods represents a central issue in modern sports nutrition, as these sources are often positioned dichotomously in athletic practice. Based on the synthesized literature, it can be concluded that both protein supplements and whole-food protein sources are similarly effective in supporting muscle mass gains and recovery, provided that total daily protein intake meets physiological requirements. Differences between the two are largely functional and contextual rather than rooted in fundamental biological effects.

Physiological and Anabolic Characteristics of Protein Supplements

Protein supplements, particularly whey protein, are formulated to deliver high-quality protein in a practical, rapidly digestible, and easily consumed form. Whey protein contains a complete essential amino acid profile with a high proportion of leucine, making it highly effective in stimulating muscle protein synthesis via activation of the mTOR pathway. Its rapid digestion leads to a swift rise in plasma amino acid concentrations, which may be advantageous during the post-exercise period when muscle tissue exhibits heightened anabolic sensitivity.

Intervention studies consistently demonstrate that protein supplementation increases lean body mass and muscle strength, particularly in individuals with low baseline protein intake or athletes with elevated protein demands due to high training volumes. However, meta-analytic evidence indicates that these benefits plateau at approximately 1.6 g/kg body weight per day. Beyond this level,

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additional protein intake whether from supplements or other sources does not consistently result in further muscular adaptations.

These findings suggest that the primary advantage of protein supplements lies not in their ability to elicit a unique anabolic response, but rather in their convenience and efficiency in helping athletes meet daily protein requirements. Thus, protein supplements function as a nutritional aid rather than a primary determinant of muscle hypertrophy.

Effectiveness of Whole-Food Protein in Muscle Adaptation

Protein derived from whole foods such as beef, poultry, fish, eggs, milk, and dairy products has long been a cornerstone of athletic diets. Several intervention studies directly comparing whole-food protein sources with protein supplements report no significant differences in muscle mass or strength gains when protein and energy content are matched.

Whole foods provide a complete amino acid profile capable of effectively supporting muscle protein synthesis, despite generally slower digestion rates compared with whey protein. This slower digestion may offer a more sustained release of amino acids, contributing to prolonged support of muscle protein balance over time.

In addition, whole foods provide a wide range of supporting nutrients not present in isolated protein supplements. Nutrients such as iron, zinc, B-complex vitamins, calcium, phosphorus, and bioactive compounds including naturally occurring creatine and antioxidants play important roles in energy metabolism, neuromuscular function, and muscle tissue repair. These attributes position whole foods not only as protein sources but also as integral components of long-term athlete health and performance.

Comparison in the Context of Recovery

In post-exercise recovery, both protein supplements and whole foods contribute to the repair of muscle tissue damaged by exercise-induced microtrauma. Adequate protein intake enhances muscle protein synthesis,

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suppresses protein breakdown, and accelerates the restoration of muscle strength and function.

However, several studies suggest that whole foods may offer additional recovery benefits due to their anti-inflammatory and antioxidant nutrient content. Bioactive compounds present in whole foods can attenuate excessive inflammatory responses and oxidative stress associated with high-intensity exercise. Consequently, recovery supported by whole-food consumption tends to be more holistic, addressing not only muscle repair but also systemic recovery.

Protein supplements, on the other hand, are particularly advantageous in specific situations, such as reduced appetite, dense training schedules, or acutely elevated protein requirements. Under such conditions, supplements can help prevent protein deficits that may otherwise impair recovery.

Plant-Based Protein as a Bridge Between Supplements and Whole Foods

Emerging evidence indicates that plant-based proteins, whether consumed as whole foods or supplements, can produce effects comparable to animal-based proteins when consumed in sufficient quantities. Plant proteins generally contain lower leucine concentrations, necessitating higher intake levels or strategic combinations of protein sources to achieve optimal anabolic responses.

These findings emphasize that protein effectiveness is not determined solely by its origin (animal vs. plant), but rather by total dose, amino acid quality, and training context. Accordingly, athletes adhering to specific dietary preferences can achieve optimal muscle adaptations without reliance on a single protein source.

Practical Implications for Athletes

Overall, the primary distinction between protein supplements and whole-food protein lies in practicality rather than inherent biological effectiveness. Protein supplements excel in convenience, dosing precision, and rapid consumption, whereas whole foods offer superior nutritional diversity, long-term health benefits, and comprehensive recovery support.

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Therefore, the most rational nutritional strategy is to prioritize whole foods as the foundation of an athlete's protein intake, while using protein supplements strategically and contextually as complementary tools. This approach aligns with evidence-based sports nutrition principles that emphasize intake adequacy, dietary quality, and individualized athlete needs.

CONCLUSION

Based on the study objectives and the synthesis of scientific evidence conducted, it can be concluded that protein sources play a crucial role in supporting muscle mass gains and accelerating recovery in athletes. The main findings indicate that both protein derived from supplements and protein obtained from whole foods are equally effective in promoting muscle adaptation and recovery processes, provided that daily protein intake meets the athlete's physiological requirements.

The effectiveness of protein in enhancing muscle mass and recovery is not determined solely by the protein source, but is more strongly influenced by the adequacy of total intake, the quality of the amino acid profile, and its alignment with training intensity and type. Accordingly, athlete protein requirements, which generally range from 1.6–2.0 g/kg body weight per day, can be met through various protein sources, including both animal- and plant-based proteins, as long as they are consumed in sufficient amounts.

These conclusions emphasize that the use of protein supplements is complementary and contextual, particularly under conditions of time constraints or elevated protein demands, while whole foods remain highly relevant as the primary protein source that supports comprehensive recovery. Future research employing experimental designs that directly compare different protein sources across diverse athlete populations is warranted to strengthen and refine sport nutrition recommendations that are more specific and practically applicable.

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