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The Effectiveness of using High Protein Products in the Context of Muscle Mass Gain: A review of the Literature

Agnieszka Ewelina Markiewicz
ORCID: 0009-0009-3344-9115
ine.wojciechowska@gmail.com
Cardinal Stefan Wyszyński Province Specialist Hospital in Lublin,
al. Kraśnicka 100, 20-718 Lublin, Poland

Marek Jarosław Molenda
ORCID 0009-0002-7900-4970
markollo1998@gmail.com
4th Clinical University Hospital in Lublin,
ul. Kazimierza Jaczewskiego 8, 20-954 Lublin, Poland

Maria Wachowska
ORCID: 0009-0004-2069-9469
maria.wac97@gmail.com
Podhale Specialist Hospital named after St John Paul II in Nowy Targ,
ul. Szpitalna 14, 34-400 Nowy Targ, Poland

Marta Szymura
ORCID: 0009-0000-2776-8974
martaszymura3581@gmail.com
Independent Public Healtcare Center No.1 in Rzeszów,
ul. Tadeusza Czackiego 2 35-051 Rzeszów, Poland

Mateusz Paniak
ORCID: 0009-0009-0110-9634
mateuszpaniak.mp@gmail.com
Cardinal Stefan Wyszyński Province Specialist Hospital in Lublin,
al. Kraśnicka 100, 20-718 Lublin, Poland

Mateusz Romaniuk
ORCID: 0009-0007-1486-5522
mateusz.romaniuk.44@gmail.com
Independent Public Health Care Center of the Polish Ministry of Interior and Administration in Lublin, ul. Grenadierów 3, 20-331 Lublin, Poland

Michał Brunon Krawczyk
ORCID: 0009-0008-9697-6548
michalkrawczyk@gumed.edu.pl
Pediatric Cardiac Surgery Department of Mikołaj Kopernik Hospital in Gdańsk,
ul. Nowe Ogrody 1, 80-803 Gdańsk, Poland

Oliwia Brygida Woszczyńska
ORCID: 0009-0001-7724-544X
ob.woszczynska@gmail.com
Independent Public Health Care of the Ministry of the Internal Affairs,
ul. Kartuska 4/6, 80-104 Gdańsk, Poland

Paweł Maciej Rycąbel
ORCID: 0009-0008-4039-8312
pawelrycabel@gmail.com
Independent Public Health Care Center of the Polish Ministry of Interior and Administration in Lublin, ul. Grenadierów 3, 20-331 Lublin, Poland

Wojciech Jan Sowiński
ORCID: 0000-0002-2267-4773
wojciechjansowinski@gmail.com
1st Military Clinical Hospital with the Outpatient Clinic,
al. Racławickie 23, 20-049 Lublin, Poland

Abstract

Introduction:

High-protein food is widely recommended in sports dietetics as a key component to support muscle hypertrophy. More products with higher amounts of protein in the ingredients are being introduced to the market. Among the products that are available there are both animal and plant-based products, including dietary supplements, fermented milk drinks, protein bars and other high-protein snacks. The diversity of forms, flavour profiles and nutritional composition of these products allows them to be customised to meet individual dietary needs, consumer preferences and varying dietary patterns.

Materials and Methods:

This article presents a review of scientific studies from the years 2015-2025 available in the PubMed database on the effectiveness of protein supplementation for muscle mass gain in physically active individuals and athletes.

Research Objective:

The aim of this review is to bring together the current knowledge on the role of higher protein intake and supplementation in the diet. Particular attention is paid to the quantity and quality of protein intake, types of supplements, biochemical mechanisms determining hypertrophy and potential side effects of excessive protein supply.

Results and Conclusions:
Protein supplementation combined with customized physical activity is needed to accelerate muscle tissue growth. Further research on protein supplementation is needed, as current findings do not yet allow definitive conclusions.

Key words:
protein, muscle hypertrophy, protein supplementation, high protein product, resistance training, plant proteins, animal proteins

1. Introduction

Proteins play a key role in the human organism, performing a variety of functions necessary for its proper functioning [1]. They are the basic component of the intracellular and extracellular matrix; they build enzymes that catalyse a number of biochemical reactions, hormones that regulate endocrine balance and receptors that initiate cellular responses; they are part of the molecules that transport various components; they have the ability to bind and retain water in their structures; they regulate pH, being responsible for maintaining acid-base balance; they protect the body against infections by fighting pathogens; they are the main component of muscles, being responsible for contractility and movement. [2]

An adequate supply of protein is essential for the body to function properly. Dietary protein is a source of the amino acids necessary for the synthesis of the organism's own proteins. In terms of the content of individual amino acids and their proportions to each other, we divide proteins into complete and incomplete proteins. The former are mainly of animal origin and provide all amino acids in the right proportions. The latter are so-called incomplete proteins which are of plant origin and do not contain the full set of amino acids, often lacking or having insufficient quantities of amino acids such as lysine, tryptophan, methionine and valine [3]. A protein that contains a complete and optimal amino acid profile for the human organism is a reference protein, which does not exist in nature. It provides a reference point for assessing the nutritional value of other proteins by comparing their amino acid composition with the reference protein. Egg white is the nearest in composition to the reference protein and is therefore considered the reference protein in many publications [4,5]. The minimum recommended intake of protein in the human diet is 0.8 g per kilogram of body weight per day [6], while in the Polish population the standard is 0.1 g/kg higher and amounts to 0.9g/kg body weight per day. This value has been established on the basis of studies determining the amount of protein required to maintain nitrogen balance, and it is assumed that this amount of dietary protein will meet the needs of approximately 97.5% of the healthy adult population [7].

Results from global studies indicate that almost all populations of the world achieve protein intake levels equal to or above the minimum recommended values in the dietary standards. This means that the average daily protein intake in most societies is sufficient to cover the basic needs of the organism [8]. Therefore, this article discusses in detail the various dietary styles that place particular emphasis on increased dietary protein supply.

The aim of this article is to provide a comprehensive review of the scientific literature on the impact of protein intake above the Recommended Dietary Allowance (RDA) on human health. It will analyse both the potential benefits of higher protein intake, maintenance of muscle mass, improvement of metabolic parameters and bone health, and the possible risks associated with an excessive supply of this macronutrient. The article aims to assess the current state of knowledge in this area, to draw conclusions on the validity of recommending higher-than-standard amounts of protein in the diets of different population groups and to assess the validity of the present trend of popularising high-protein products.

2. Biochemical mechanisms

In the human body, a dynamic process called protein turnover is constantly taking place, which includes both protein synthesis and protein degradation. Every day, approximately 1-2% of proteins are degraded and replaced by newly synthesised proteins. This continuous cycle allows adaptation to changing conditions and repair of damaged protein structures [9].

Skeletal muscle is the largest tissue in the human body, accounting for approximately 30-40% of total adult body weight [10, 11]. The main mechanism underlying muscle hypertrophy is the predominance of muscle protein synthesis (MPS muscle protein synthesis) over muscle protein degradation (MPB, muscle protein breakdown). Both of these processes are necessary for the proper development of muscle tissue and must remain in balance with each other. Potentially, it could appear that a complete inhibition of MPB will accelerate the MPS process, as it reduces the body's expenditure of time and energy in breaking down muscle fibres. The incorrectness of this assumption has been proven in animal models, in which genetic interference blocked the proteolysis of muscle proteins in the complete absence of interference in the mechanisms responsible for muscle synthesis. Such genetically modified rodents exhibited poorer exercise tolerance and lower single muscle fibre volume [12].

Skeletal muscle tissue is characterised by a high sensitivity to nutrients supplied with food. It accurately reads the changes that occur in the body during digestion and absorption of food, e.g. changes in insulin concentration and the composition of supplied substrates, and on the basis of this analysis it initiates the process of muscle fibre synthesis or degradation. Usually these processes occur simultaneously and, depending on which one predominates, muscle tissue expansion or atrophy occurs [13]. Exogenous amino acids, especially leucine, are key stimulators of MPS as they stimulate muscle synthesis in a dose-dependent manner through direct activation of mTORC1 (mammalian target of rapamycin complex 1). MTORC1 is a signalling protein that is located in myocytes and is responsible for the adaptation of muscle to resistance training through the synthesis of new muscle myofilaments [12]. Studies have shown that the ingestion of at least 20-40 g of high-quality protein after resistance training significantly stimulates MPS [14,15].

3. The role of the amount and type of protein

The synthesis and expansion of new muscle fibres depends primarily on the amount and quality of externally supplied protein. Adequate intake of complete protein is the basis for building muscle mass. Protein intake recommendations for active people are higher than the recommended intake for the general population and range from 1.4 to 2.0 g/kg body weight/day. A higher protein intake above the dietary norms is not recommended, as it does not provide additional benefits in terms of accelerated muscle hypertrophy. Even for athletes using resistance training, a protein intake reaching the upper end of the range of the stated norm is sufficient [16].

It is noteworthy that, of the protein consumed, only a small proportion, approximately one fifth, of the total amino acids that enter the organism is allocated to skeletal muscle protein synthesis, while the rest serves as a substrate for the synthesis of other proteins or undergoes catabolism [13]. This is why the type of protein chosen for supplementation is so important. In terms of muscle mass development, animal proteins such as whey protein, milk protein or beef protein compare favourably, significantly increasing the postprandial MPS response compared to plant proteins [17]. However, diets rich in animal protein often contain higher amounts of saturated fat, which can raise the level of LDL cholesterol in the blood, increasing the risk of cardiovascular disease [18] and deficiencies in other essential nutrients and fibre [19].

Among animal proteins, whey protein deserves special attention. Comparative studies indicate that it has a higher anabolic potential than other protein sources such as soya or casein [20], due to its high bioavailability, favourable amino acid profile - rich in branched-chain amino acids (BCAA) especially leucine - and faster digestion time [21].The most commonly used dietary supplement containing whey protein is whey protein concentrate (WPC). This product is made by the ultrafiltration of dairy whey, a by-product of cheese production. WPC is characterised by a high protein content of 70% to 80% of the weight of the product, with the remainder consisting of carbohydrates (mainly in the form of lactose) and fats [22]. A kind of exception among animal proteins is collagen. In its natural form, it is difficult to digest and has a low bioavailability due to its specific structure and limited nutritional value [23]. It is avoided in the production of nutritional supplements influencing muscle development, while it is successfully used in supplements for the skin, joints and bones [24, 25].

The above-mentioned plant proteins, despite showing a number of health benefits, such as supporting the prevention of cardiovascular and metabolic diseases, positive effects on healthy ageing and mental health [26, 27], they are less effective than proteins of animal origin in the context of muscle tissue expansion and are often omitted in the diet. Soy proteins are characterised by a lower content of essential amino acids, especially leucine. In addition, their bioavailability and biological value are lower compared to animal proteins, which may limit maximisation of muscle mass gain [5]. However, appropriately composed blends of plant proteins, enriched in leucine, can approach the effectiveness of animal proteins [28], providing an alternative for people who wish to avoid animal products in their diet and promote a sustainable diet [29]. It is surprising that leucine from rice protein has a unique absorption kinetics, reaching peak blood concentrations more rapidly than leucine from whey protein. In a study in which participants followed a resistance training programme for eight weeks while taking high, identical doses of rice or whey protein, it was shown that rice protein supplementation led to comparable effects on body composition changes and muscle adaptations as whey protein supplementation [30]. However, plant-derived proteins are associated with high levels of phytoestrogens, which inhibit mTOR expression in skeletal muscle which reduces the effectiveness of muscle adaptations in response to resistance training [31].

4. Protein consumption time

Randomised controlled trials show that protein supplementation significantly accelerates muscle hypertrophy when combined with resistance training. This raises the question about the optimal timing of protein intake in the context of muscle mass gain. This issue is still under discussion and the research that is being conducted in this area requires further experiments. It was once thought that protein intake in the so-called narrow anabolic window, defined as the first 45 min to 1 hour after training, maximises the MPS process [32], but the current analyses claim that protein intake both before and after training leads to similar effects on muscle strength, hypertrophy and body composition. This means that there are no significant differences depending on whether protein is consumed before or after training, in both cases it can positively affect muscle hypertrophy [33]. There is growing evidence in the scientific literature to support the validity of protein supplementation before bedtime as a strategy to support the anabolic processes occurring in skeletal muscle during overnight recovery. Studies show that overnight protein supplementation promotes the maintenance of a positive nitrogen balance, which is beneficial for training adaptation [34]. It has been shown that consuming 30-40 g of casein within 30 minutes before sleep can increase MPS rates and improve strength and muscle growth [35]. Therefore, protein supplementation before bed may be considered an effective dietary intervention in the context of optimising muscle recovery and hypertrophy [36].

However, long-term research indicates that the superior strategy to influence muscle tissue development is to ensure that daily protein intake is within the defined normal range. Ensuring a positive protein balance is far more effective than trying to find the right time to consume protein [5].

5. Potential side effects:

5.1 Renal function at higher protein intakes than the RDA

It is a popular myth that increased dietary protein intake reflects negatively on kidney function [37]. Obviously, a high protein diet increases the blood flow and pressure in the glomerulus, resulting in increased filtration, but this is a phenomenon that is an adaptation to increased protein supply [38]. Most randomised clinical trials have been conducted on participants with already reduced renal function; in such individuals, even short-term increases in filtration negatively affect renal function, hence a low-protein diet is reasonable in such individuals [39]. It is an error to assume that the kidneys of healthy people are affected to the same extent by hyperfiltration as the kidneys of people with pre-existing disease. In practice, transient hyperfiltration is a physiological phenomenon that does not adversely affect or cause deterioration of function or initiation of renal disease in a healthy person [38].

5.2 Bone metabolism function at a higher protein intake than the RDA

A second equally frequently raised issue in the context of the use of protein supplements is their alleged negative impact on bone health [40]. It has been noted that a protein-rich diet causes a decrease in pH in the body. To counteract this, the organism increases the concentration of alkaline minerals such as calcium. It was erroneously thought that the mobilisation of this element occurs from the bones, in fact its reserves came mainly from increased intestinal absorption [41], therefore there is no sufficient evidence that higher protein intake, with a normal dietary calcium supply, causes bone decalcification, leading to osteopenia or osteoporosis. It is worth noting that an increase in muscle mass translates indirectly into an increase in IGF-1 level, which has an anabolic effect on bone tissue cells [42, 43]. To conclude, in individuals following a proper balanced diet, protein intake higher than 1.4 - 2.0 g/kg/day is not harmful [16].

6. Conclusion

Using high-protein products is an effective strategy to support muscle mass gain in physically active individuals. In particular, supplements containing whey protein are recommended, while dairy and vegetable proteins may be less optimal, and collagen proteins should usually be avoided due to their limited nutritional value. Adequate protein intake and high bioavailability of the protein source is more important than the timing of the protein intake. In trained individuals, the recommended amount is approximately 1.6-2.0 g/kg body weight/day. Further research could focus on the long-term effects of protein on body composition and individual metabolic differences.

Statement of the authors' contribution

Conceptualization: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Methodology: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Software: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Check: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Formal analysis: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Investigation: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Resources, data curation: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Writing - rough preparation: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Writing - review and editing: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Visualization: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Supervision: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

Project administration: Agnieszka Markiewicz, Marek Molenda, Maria Wachowska, Marta Szymura, Mateusz Paniak, Mateusz Romaniuk, Michał Krawczyk, Oliwia Woszczyńska, Paweł Rycąbel, Wojciech Sowiński

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