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Is Plant Protein Equally as Effective at Promoting Lean Muscle Mass Compared to Meat?

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ABSTRACT

In the past few decades, there has been an increased emphasis on plant-based diets. While plant-based diets have many cardiovascular and environmental benefits, little is known about how plant-based diets specifically impact athletic performance and promote muscle growth. Many athletes are reluctant to adopt plant-based diets, fearing that they will lose lean muscle mass due to insufficient protein content. In this research review, we evaluate factors that differentiate plant proteins and meat in regard to optimal lean muscle synthesis. One of the more important differences between plant protein and meat is their amino acid composition. Since meats contain all 9 essential and many nonessential amino acids, they have a more "well-rounded" amino acid composition, thus being more effective at promoting lean muscle growth. A protein source's amino acid composition, along with other factors such as cell structure, affects its bioavailability. Due to differences in protein bioavailability, different quantities of distinct protein sources may need to be consumed to reach the same anabolic effect. In addition to amino acid compositions, nutrient densities also differ between plant proteins and meats. Although there are some exceptions, plant-based proteins tend to offer a more balanced profile of minerals and nutrients, which also facilitate lean muscle synthesis on the chemical level. Overall, an omnivorous diet may be optimal for muscle growth, but introducing a variety of plant proteins with different amino acid and nutritional profiles can help overcome this variance.

Introduction

Skeletal muscle is one of the most fundamental aspects of human functionality and athletic performance. The preservation and synthesis of muscle protein promote essential human functions–including generating movement, contributing to the basal metabolic rate, and maintaining blood glucose levels (Frontera & Ochala, 2015). Lean muscle is often responsible for various aspects of athletic performance, such as strength and agility. However, in order to adequately promote muscle synthesis, proper nutrition must be paired with sufficient muscular stimulation. Micronutrients, such as Zinc (Zn^{2+}) or Magnesium (Mg), are responsible for muscle repair and recovery, while the macromolecule protein is primarily responsible for muscle synthesis and growth (Atherton & Smith, 2012; Giugliano & Millward, 1987). Although research supports the necessity for protein in muscle synthesis, there is a heavy controversy over the amount and quality of protein, especially for athletic performance. Gaining lean muscle mass allows athletes to perform at a higher level, whether it be lifting more weight, accelerating faster, or recovering faster. With adequate consumption of protein, athletes are able to perform better at competitions, which reflects their ability to push themselves further during practice sessions (Lemon & Proctor, 1991).

There are two main diets that people follow to fulfill their dietary requirements: plant-based and omnivorous. A plant-based diet is a lifestyle where most of the necessary nutrients and macromolecules come from plant-based produce–which may include grains, vegetables, legumes, fruits, nuts, and seeds. An omnivorous diet is a system where nutrients and protein come from both plants and meat products (Lea et al., 2006). For the past few decades, attention has shifted towards plant-based eating. Many proponents of plant-based eating claim that its benefits outweigh the necessity for meat. Daily fiber and nutrient intake tend to increase with higher consumption of fruits and vegetables. Plant-based diets also generally provide lower amounts of saturated fat, which promotes cardiovascular health and helps to prevent chronic disease. The animal welfare and rights movement has also converted many to a plant-based system of eating (Shaw et al., 2022). However, proponents of a meat-centered diet argue that meat has higher anabolic properties than its vegetable counterparts. They also argue how lean protein sources, such as white fish and chicken breast, also tend to promote more efficient muscle synthesis and growth. Additionally, red meat provides the body with many nutrients as well, including iron, zinc, and B12 vitamins (McAfee et al., 2010). While both these diets provide various sources of protein required for lean muscle synthesis, many argue that the critical difference between plant protein and meat is the quality of protein and the quantity needed for muscle synthesis.

The aim of this review paper is to assess the benefits and drawbacks of using plant-based versus meat-centered protein sources to facilitate muscle synthesis and increase lean body mass in athletes. We will evaluate factors such as amino acid composition, bioavailability, consumption quantity, and nutrient availability to determine if one diet is better for lean muscle mass growth. We will also discuss approaches to modifying both diets to optimize athletic performance by increasing muscle mass.

Amino Acid Composition

In chemical terms, amino acids are organic substances that contain an amino group, an acidic carboxyl group, and an R group. An amino group is simply nitrogen bonded to either carbons or hydrogens. Each amino acid is centered around a carboxyl group with an attached "R group," which gives the amino acids their specific chemical properties depending on the R composition. One of the main functions of amino acids is to facilitate protein synthesis (Wu, 2009). Amino acids activate the mTORC1 pathway, which starts the translation process from mRNA to protein. During translation, amino acids are configured and processed into muscle proteins to create muscle tissue (Kamei et al., 2020).

Amino acids are generally classified into one of two groups: essential and non-essential. Essential amino acids are compounds that the human body can't synthesize due to the absence of certain metabolic pathways. As a result, essential amino acids must be consumed from an external diet (Frank et al., 2021). The human body needs twenty different amino acids to function, nine of which are essential. Non-essential amino acids are compounds that are already synthesized by the human body in sufficient amounts for necessary functions (Wu et al., 2013). Glycine is one of the most important non-essential amino acids for muscle synthesis. It acts as a precursor for various metabolites, such as creatine, which help promote lean muscle growth (Razak et al., 2017). If there is an inadequate essential amino acid intake, lean muscle growth may plateau or even diminish. These effects can also be observed beyond muscles; fragile hair, fatigue, and growth stunting are all signs of insufficient amino acids (Allowances, 1989).

Since plant proteins and meat have different amino acid compositions, their effectiveness at promoting muscle synthesis varies. Meat is considered a "complete protein" because it proves all nine amino acids per serving, while plant proteins are typically "incomplete" as they lack one or more of the essential amino acids (Hoffman & Falvo, 2004). Plant proteins generally tend to have lower and/or insufficient amounts of essential amino acids compared to meat.

Table 1. Plant Protein v Meat Amino Acid Composition

Food Name	Histidine (g)	Isoleucine (g)	Leucine (g)	Lysine (g)	Methionine (g)	Phenylalanine (g)	Protein (g)	Threonine (g)	Tryptophan (g)	Tyrosine (g)	Valine (g)

Chicken Breast, Skin Removed Before Cooking	0.82	1.39	1.97	2.23	0.73	1.04	26.29	1.11	0.31	0.89	1.3
Hamburger or Ground Beef, 80% Lean	0.7	0.95	1.67	1.78	0.55	0.84	21.47	0.83	0.11	0.66	1.05
Salmon, Atlantic, Wild, Cooked	0.64	1	1.76	1.99	0.64	0.84	21.64	0.95	0.24	0.73	1.11
Eggs, Cooked	0.25	0.58	0.91	0.77	0.33	0.57	10.7	0.51	0.13	0.44	0.65
Yogurt, Plain, Whole Milk	0.21	0.46	0.86	0.76	0.25	0.46	8.5	0.35	0.05	0.43	0.7
Black Beans, Canned, Drained	0.18	0.33	0.6	0.45	0.1	0.41	7.08	0.25	0.09	0.17	0.43
Tofu, Raw (Not Silken), Cooked, Firm	0.36	0.72	1.18	0.75	0.18	0.71	14.67	0.67	0.2	0.6	0.74
Green Peas, Cooked from Frozen	0.2	0.37	0.61	0.6	0.16	0.38	10.3	0.39	0.07	0.22	0.45
Quinoa, Cooked	0.12	0.15	0.24	0.22	0.09	0.17	4.07	0.12	0.05	0.08	0.17

*Data obtained from Cronometer

Plant proteins and meats have significantly different amino acid compositions per serving as seen in Table 1. All meats are standardized to a 3 oz serving, while plant proteins are portioned at the recommended serving size, typically ½ cup. Meats tend to have over two times the volume of each amino acid, which is measured in grams per serving. Meats, such as chicken breast and wild salmon, contain the most grams of amino acids, while plant proteins such as beans and peas tend to contain the least. Tofu contains one of the highest volumes of amino acids among all plant proteins.

While there are amino acid variations in all sources, the biggest difference between plant protein and meat is in branch chain amino acids (BCAAs), which are a subset of essential amino acids. The branched-chain amino acids–leucine, isoleucine, and valine–are especially important in muscle protein synthesis (Wolfe, 2017). They work with insulin to activate the chemical pathways which facilitate lean muscle synthesis. Specifically, BCAAs promote the phosphorylation of proteins in the mTOR chemical pathway, which helps to build and maintain existing muscle (Blomstrand et al., 2006).

These branch chain amino acids are highly involved in lean muscle synthesis, which is why this amino acid difference between plant proteins and meat is important. Leucine is the most important amino acid for muscle growth, as it provides a signal that amino acids are present in the body, which stimulates muscle protein synthesis Not only is leucine a stimulator of the mTORC1 chemical pathway, but it also increases insulin sensitivity. Insulin not only increases amino acid uptake, which stimulates the growth of muscle protein and glycogen but also prevents muscular degradation (Garlick, 2005).

Protein Quality

Table 2. Protein Corrected Amino Acid Score

Food Name	**PDCAA Score**
Chicken Breast	96
Ground Beef	92
Wild Salmon	95
Eggs	97
Yogurt	74
Black Beans	75
Tofu	57
Peas	60
Quinoa	88

*Data obtained from 2000KCAL

Omnivorous diets inherently provide a wider representation of various amino acids because many meat sources are “complete” protein sources. As the body breaks down meat into these amino acids, they can better be utilized to signal chemical pathways to build muscle fibers and help muscular recovery due to the presence of these essential amino acids. Although the quantity of essential amino acids is important, protein quality also determines how effective a protein source is at promoting lean muscle mass. Protein quality is defined as the ability of a certain protein source to meet metabolic goals for the growth and maintenance of muscle tissue. One measure of protein quality is the Protein Digestibility Corrected Amino Acid Score.

The Protein Digestibility Corrected Amino Acid Score (PDCAAS) is an indicator of how effectively protein can be metabolized by the human body. The PDCAA score reflects a protein’s ability to meet the body’s amino acid requirements. This score is critical because they allow researchers to directly compare different sources against each other in order to view their effectiveness. These quantitative values are measured by multiplying the ratio of a limiting amino acid of a specific protein to a standardized reference. PDCAA is a score ranging from 0 to 100. Protein sources with a PDCAA score of 1 are considered to meet the body's amino acid requirement (Berrazaga et al., 2019).

In addition to having higher concentrations of essential amino acids, meats have significantly higher PDCAA scores compared to plant proteins. Animal sources such as eggs have an extremely high score of 97, while most plant proteins range from 50 to 70 with a few exceptions. Quinoa is one of the most effective sources of plant protein, with a PDCAA score of 88 [Table 2]. More popular sources such as beans, nuts, and grains have significantly lower scores, which means that they are not as effective at providing all the required amino acids for muscular performance and function.

Table 3. Biological Value

Food Name	**Biological Value Score**
Chicken Breast	79
Ground Beef	74
Wild Salmon	76
Eggs	94
Yogurt	90
Black Beans	58
Tofu	74
Peas	65
Quinoa	83

*Data obtained from ExpertsMind

While the PDCAAS is a good measure of protein "quality", it is limited to just amino acid requirements and digestibility. The effectiveness of a protein at promoting lean muscle mass is determined by many more factors. Biological value (BV) is another measure of protein quality that considers protein utilization. BV is the proportion of absorbed protein that becomes part of the human body. Since most of the body's nitrogen comes from protein, BV is measured by dividing the incorporated nitrogen by the absorbed nitrogen (Mitchell, 1924; Volpi et al., 2003).

Similar to the PDCAA score, the biological value of meat is significantly higher than plant proteins. The biological value of a protein source is scored on a scale of 0 to 120. The highest biological value scores come from eggs, with a score of 94, while the highest plant protein BV score comes from quinoa, with a score of 83 [Table 3]. This BV difference could suggest that meats are more effective at promoting lean muscle mass. Meats generally contain a higher biological value than plant protein due to their "complete" amino acid nature (Hoffman & Falvo, 2004). However, this system is not absolute as it fails to consider other key factors such as cell structure and fiber.

Table 4. Fiber Content

Food Name	Fiber (g)
Chicken Breast, Skin Removed Before Cooking	0.00
Hamburger or Ground Beef, 80% Lean	0.00
Salmon, Atlantic, Wild, Cooked	0.00
Eggs, Cooked	0.00
Yogurt, Plain, Whole Milk	0.00
Black Beans, Canned, Drained	9.03
Tofu, Raw (Not Silken), Cooked, Firm	1.46
Green Peas, Cooked from Frozen	9.00
Quinoa, Cooked	2.59

*Data obtained from Cronometer

Plants and meat have different protein structures, which affect their digestibility. Fiber may reduce protein digestibility which could contribute to reduced PDCAA and biological value scores ("The Effect of Fiber on Protein Digestibility," 1984). Compared to meat, plant proteins have a secondary structure with high β-sheet conformation and α-helix amount. This high β-sheet conformation may make it more difficult for enzymes to break down protein peptides into amino acids (Carbonaro et al., 2012). Plant proteins have significantly more fiber per serving, with black beans containing the most at 9.03 grams per half-cup [Table 4]. Since meat contains low amounts of fiber, the amino acids it provides may be absorbed and digested more efficiently.

Protein Quantity

As a result of the lower essential amino acid content, digestibility, and absorption of plant proteins, different quantities of meat and plant proteins are needed for the same biological effect. Research shows that around 1.6 grams of protein per kilogram of body weight are recommended for optimal muscle growth. Additional protein may be beneficial, but effectiveness slowly tapers off after the 1.6 g/kg mark (Stokes et al., 2018). However, one gram of protein from meat is different than the same quantity from a plant protein source. As the ratio of plant protein consumed relative to meat increases, the overall protein quality in one's diet decreases. While many individuals may consume a high enough quantity of protein, many are not getting the full effect or optimal "protein quality" if they are relying abundantly on plant protein, due to its decreased digestibility and amino acid deficiencies (Moughan, 2021). This deficiency may affect athletic performance. A study showed that while vegetarian athletes got enough protein, this protein was only 89% utilized compared to an omnivorous diet. While this did not explicitly harm these athletes, they were not able to reach their optimal protein goal. However, for pure vegans, this value might be even lower due to the complete absence of plant protein (Ciuris et al., 2019). Thus, individuals consuming a plant-based diet may have to consume a higher quantity of protein in order to gain the same metabolic effect as omnivores (Buczkowska & Jarosz-Chobot, 2001).

Nutrient Density

Creatine Monohydrate

Creatine monohydrate is a compound that plays an integral part in energy production and metabolism. In human cells, creatine is phosphorylated to generate phosphocreatine, a molecule that facilitates the production of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) (Branch, 2003). Since ATP is the cell's molecule for energy, optimal creatine amounts in cells can lead to enhanced strength and stamina, which increase muscle hypertrophy and promote lean muscle synthesis. Sustained creatine presence has resulted in increased 1-RM for various strength tests, including squats and bench-presses (Bird, 2003; Volek et al., 2004).

Table 5. Creatine Content

Food Name	Creatine Content (g/100g)
Chicken Breast	0.4
Ground Beef	0.9
Wild Salmon	0.9
Eggs	0.01
Yogurt	0.02
Black Beans	-
Tofu	-
Peas	-
Quinoa	-

*Data obtained from Fitbod

Although creatine is readily available in supplementation form, it is abundant in select protein sources. Creatine is inherently found in aminal proteins such as herring or pork. Just like humans, animals also store creatine in their muscle cells, thereby making meat a good source of natural creatine. However, plants contain trace amounts of creatine due to their absence of muscle tissue [Table 5]. Due to these lower amounts, pure plant-based diets are unable to supply any naturally occurring creatine for muscle synthesis. The absence of consumed creatine could limit the production of muscle tissue compared to creatine-abundant omnivorous diets.

One solution which compensates for a plant's absence of creatine is creatine supplementation. Creatine supplementation will even increase lean muscle mass for omnivores, but its effects are substantially more significant on those who follow a plant-based diet. Studies have shown that optimal creatine supplementation can increase lean muscle synthesis significantly over an 80-day period (Francaux & Poortmans, 1999). Supplementation can provide optimal doses of creatine which could enhance muscle stimulation through an increase in net ATP production.

Magnesium

Magnesium is another crucial mineral responsible for muscle recovery and lean muscle mass synthesis. On the cellular level, mitochondria are responsible for producing ATP, the human body's source of energy. ATP is responsible for fueling actions that cause muscular hypertrophy, which causes lean muscle synthesis. Magnesium acts as a cofactor of several important mitochondrial enzymes and a regulator of various channel ions; both are responsible for optimal energy production from the mitochondria (Pilchova et al., 2017). An inadequate presence of mitochondrial magnesium reduces net ATP production, which can impact lean muscle synthesis (Yamanaka et al., 2016).

Table 6. Magnesium Content

Food Name	Magnesium (mg)
Chicken Breast, Skin Removed Before Cooking	22.96
Hamburger or Ground Beef, 80% Lean	16.16
Salmon, Atlantic, Wild, Cooked	31.47
Eggs, Cooked	8.50
Yogurt, Plain, Whole Milk	29.40
Black Beans, Canned, Drained	45.58
Tofu, Raw (Not Silken), Cooked, Firm	60.04
Green Peas, Cooked from Frozen	44.00
Quinoa, Cooked	59.20

*data obtained from Cronometer

Although magnesium is present in a variety of both plants and meats, there is a significant difference in their magnesium content [Table 6]. Although meat–such as salmon or chicken–is a good source of magnesium, these concentrations are low compared to plants. Plants tend to have 2-4 times more milligrams of magnesium compared to equal servings of meat. Tofu and quinoa carry the greatest amount of magnesium per serving, reaching up to 60 mg per serving. While this difference is likely insignificant in promoting lean muscle mass synthesis compared to more researched factors such as amino acid composition, optimal magnesium levels may still help facilitate muscle growth and fast recovery.

This difference in magnesium is not absolute; omnivorous diets still contain a variety of plant-based foods in addition to animal meat. However, the nutritional imbalance between the two diets can be improved by incorporating more magnesium-dense foods into omnivorous diets. Increasing the number of whole grains or green vegetables can significantly improve overall magnesium levels and optimize lean muscle synthesis.

Zinc

On the cellular level, lean muscle synthesis is facilitated through stimulation of the Akt pathway. Zinc has been shown to increase the sensitivity of receptors in the Akt pathway to certain hormones, such as testosterone. Testosterone is a hormone that increases lean muscle mass by increasing muscle synthesis (Griggs et al., 1989). Increased sensitivity to testosterone increases its anabolic effects (Giugliano & Millward, 1987; Swaminath et al., 2002). Additionally, zinc has been shown to affect myogenesis and muscle regeneration due to its effects on cellular activation. Consumption of zinc-rich foods post-workout can reduce inflammation and enhance recovery (Hernández-Camacho et al., 2020).

Table 7. Zinc Content

Food Name	Zinc (mg)
Chicken Breast, Skin Removed Before Cooking	1.05
Hamburger or Ground Beef, 80% Lean	5.31
Salmon, Atlantic, Wild, Cooked	0.7
Eggs, Cooked	0.89
Yogurt, Plain, Whole Milk	1.45
Black Beans, Canned, Drained	0.89
Tofu, Raw (Not Silken), Cooked, Firm	1.35
Green Peas, Cooked from Frozen	1.34
Quinoa, Cooked	1.01

*Data obtained from Cronometer

Zinc is present in a variety of both plant-based proteins and meats [Table 7]. Both plant proteins and meats contain relatively similar amounts of zinc per serving, excluding red meat such as beef. Beef has over 4 times the zinc of most plant proteins and meats, with over 5 mg per 3 ounces. Other protein sources, such as chicken and whole grains, have around one mg per serving.

While this difference between beef and other protein sources could theoretically cause a difference in muscle synthesis for plant-based versus omnivorous diets, this variance can be reduced through a balanced diet. Although omnivorous diets provide many nutrients in meat, most zinc still comes from plant proteins and vegetables. An omnivorous diet containing beef with supplementation or the introduction of more zinc-rich food can thus provide similar quantities of zinc to a plant-based diet.

Iron

Optimal levels of iron promote muscle synthesis. Skeletal muscles contain 10-15% of the body's iron content, primarily in slow-twitching fibers. As protein is synthesized into muscle mass, the mTOR pathway–which regulates human metabolism–also produces more iron, thus supplementing muscle growth (Hurrell & Egli, 2010). Since iron is not naturally synthesized by the body, it must be absorbed from external foods. There are 2 general types of consumable iron: heme and non-heme. Heme iron can be found only in meat since it comes from hemoglobin and myoglobin. Although heme iron only contributes 10-15% of total iron intake, due to its high bioavailability, it can account for up to 40% of total iron absorption. However, non-heme iron is far less absorbed, since it is digested along with all other nutrients in the intestine (Pawlak et al., 2016).

While the relative iron content in certain meats and vegetables is comparable, the difference comes from the bioavailability of these sources. There are two types of iron: heme and non-heme iron. Heme iron

(HFe) is only found in meat and is better absorbed by the human body. Since meats have higher HFe values, they are more efficiently absorbed by the body and, therefore, can better contribute to optimal muscle synthesis. Even if both plant-based eaters and omnivores consume the same amount of iron, their absorption may differ. Vegetarians and vegans tend to have a lower iron status, which means they might have decreased muscle synthesis capacity than meat-eaters (Pawlak et al., 2016).

One way to increase iron's bioavailability is to supplement with Vitamin C, which can be found in bell peppers, berries, and citrus. The acid in Vitamin C creates the optimal environment in the intestine for iron absorption. Combining iron with Vitamin C can increase non-heme absorption by up to 4 times (Lynch & Cook, 1980). Essentially, the difference in lean muscle synthesis doesn't come from the quantity of iron consumed, but rather from the amount of iron absorbed.

Discussion

Increasing Protein Quantity

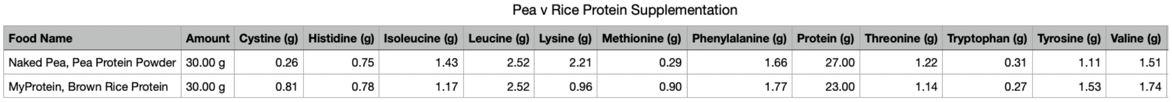
As stated before, plant protein is less effective at promoting lean muscle mass compared to meat due to factors such as essential amino acid availability, bioavailability, and digestibility. For optimal lean muscle growth, 1.2 g/kg of protein is recommended for adults (Stokes et al., 2018). While both plant-based and omnivorous individuals are able to reach this target, there may be disproportionality in their observed muscle mass. Individuals who eat more meat are able to grow and retain more muscle mass, even if they are consuming the same amount of protein as a plant-based eater (Aubertin-Leheudre & Adlercreutz, 2009). If an individual eats 100 grams of primarily meat protein, they will be able to better reach their specific protein requirements because of meat's higher protein quality; most meats have a PDCAA score close to 100. However, if this same individual consumed the same quantity of protein from plant-based sources, such as legumes, this amount would be less effective as most plant proteins have PDCAA scores of 50-70. One way for plant-based individuals to overcome this deficit is to eat higher amounts of overall protein. Individuals can better reach the recommended protein goals by increasing their protein intake to more than meat-eaters. As a result, a similar quantity of "effective" protein may be utilized for lean muscle growth. This can be achieved from either an increase in natural protein sources consumed, such as lentils and soy, or through protein supplementation.

Protein Supplementation

Protein supplementation is primarily taken through protein powders, which are often either whey, rice, or soy. Since many plant-based individuals are unable to reach optimal protein requirements compared to omnivores, protein powder supplementation is a convenient and effective way to reach the target amount (Huecker et al., 2019). Aside from just proteins, protein powders are also extremely effective due to chemical fortification and enhancements. Many protein supplements in the market contain additional BCAAs and glutamine (Gorissen et al., 2018). As a result of these factors, a protein supplement is an extremely efficient and effective way for plant-based individuals to overcome a higher protein target for optimal muscle growth.

Protein Blending

Table 8. Protein Supplementation



Pea v Rice Protein Supplementation

Food Name	Amount	Cystine (g)	Histidine (g)	Isoleucine (g)	Leucine (g)	Lysine (g)	Methionine (g)	Phenylalanine (g)	Protein (g)	Threonine (g)	Tryptophan (g)	Tyrosine (g)	Valine (g)
Naked Pea, Pea Protein Powder	30.00 g	0.26	0.75	1.43	2.52	2.21	0.29	1.66	27.00	1.22	0.31	1.11	1.51
MyProtein, Brown Rice Protein	30.00 g	0.81	0.78	1.17	2.52	0.96	0.90	1.77	23.00	1.14	0.27	1.53	1.74

*data obtained from Cronometer

Another way for plant-based individuals to accommodate the lower anabolic properties of plant protein is to blend protein sources. Since many plant protein sources and supplements are deficient in one or more essential amino acids, individuals can get a similar effect to whey or meat by blending different sources which contain a wide variety of amino acids. Blending protein allows sources to "make up for" the other's deficiencies (Moughan, 2021; Reidy et al., 2013). Pea protein, which is one of the most popular sources of vegan protein supplementation, is relatively low in the amino acid methionine but high in lysine. In contrast, rice protein is low in lysine but contains moderate amounts of methionine [Table 8]. As a result, a protein supplement that contains a blend of rice and pea protein will be more effective than rice or pea separately.

Benefits of Plant Protein

Although plant-based proteins have lower standards of protein quality compared to meat, they should not necessarily be omitted from an individual's diet. There are various benefits of a plant-based diet, which may compensate for amino acid deficiencies. Increased consumption of whole grains, vegetables, and other vegan protein sources has been shown to reduce inflammation post-workout, which may aid in recovery. Plant-based diets may also provide cardiovascular benefits, such as lower chances of strokes, obesity, and diabetes (Kahleova et al., 2017). An increase in overall metabolism also may occur with an increase in plant-protein intake (Kahleova et al., 2017). Plant proteins can be just as important and effective as meat if consumed correctly and may even provide even more benefits outside the scope of lean muscle mass synthesis.

Conclusion

Consumption of sufficient protein optimizes lean muscle mass synthesis. This protein can be provided in two ways: plant-based proteins and meat. Plant proteins include grains, nuts, and legumes, while quality meats include chicken, fish, and beef. While both plants and animals may provide adequate amounts of protein, the quality of this protein can be extremely varied to different amino acid combinations and concentrations, nutritional profiles, and bioavailability. Meat tends to contain a more complex amino acid profile compared to plant protein, thus making meat more effective at sheer lean muscle mass growth. However, there are benefits to a plant-based diet, including increased fiber intake and micronutrient consumption. Plant-based diets have also been shown to reduce inflammation, increase longevity, and prevent cardiovascular disease. Strategies to increase the quality and quantity of plant protein consumed include supplementation and protein blending. Future research should be directed towards continuing to understand these biological differences and recognizing plant-protein and meat's effects on long-term health and longevity.

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