

Effects of Cowpea Purée Supplementation and strength training on amino acid kinetics in young adults: A Pilot Study

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Abstract:

Introduction: Branched-chain amino acids (BCAAs) are essential for protein synthesis and muscle recovery and are therefore widely used in sports nutrition. Although rapidly digested animal proteins elicit strong anabolic responses, assessing plant-based alternatives such as cowpea (*Vigna unguiculata*) is essential for understanding their absorption kinetics. **Problem Statement:** Whether a dietary portion of a plant-based food matrix can raise post-exercise aminoacidemia remains unclear, given the typically lower digestibility and less complete amino acid profiles of plant proteins. **Objective:** This pilot study investigated changes in plasma BCAA concentrations after cowpea purée consumption in young adults following strength training, testing the competing hypotheses that supplementation would (H1) or would not (H0) significantly influence plasma BCAA concentrations. **Material and Methods:** Ten healthy young men participated in a repeated-measures pilot study under four conditions: control, exercise, supplementation, and combined supplementation and exercise. Participants ingested 150 g of cowpea purée (providing an estimated 5 to 6 g of protein) and performed a standardized strength training session. Blood amino acid kinetics were analyzed using HPLC-FLD, and data were treated with repeated-measures MANOVA ($p < 0.05$). **Results:** Supplementation did not significantly increase overall plasma BCAA concentrations. Leucine showed a decreasing trend over time in the supplementation plus exercise condition, isoleucine differed significantly between the control and combined conditions ($p = 0.020$), and valine showed no significant variation. **Discussion:** These findings are consistent with the slower digestion, lower leucine content and food-matrix effects of plant proteins, which may limit post-exercise anabolic signaling; the low protein dose provided by the purée (5 to 6 g) plausibly contributed to the absence of a robust aminoacidemic response. **Conclusions:** Cowpea purée supplementation under the tested conditions did not elicit a pronounced post-exercise increase in plasma BCAA kinetics, suggesting that dosage and food matrix optimization, together with controlled dietary standardization, are needed before plant-based recommendations can be established.

Key Words: Plant-based protein; BCAAs; Muscle protein synthesis; Postprandial aminoacidemia; Resistance exercise

Introduction

Branched-chain amino acids (BCAAs) are made up of leucine, isoleucine and valine and are considered essential for protein synthesis and muscle metabolism (Zhang et al., 2017). As they are not produced endogenously, they are obtained through diet or supplementation and are widely used by physical activity practitioners, especially those involved in strength and endurance training (Falavigna et al., 2012). Studies show that BCAAs play a crucial role in reducing central and peripheral fatigue, improving sports performance and promoting muscle recovery after intense exercise (Abdulkader et al., 2024; Doma et al., 2021). Leucine, in particular, plays an essential role in activating the mTOR pathway, a key mechanism for muscle hypertrophy (Jackman et al., 2017). In addition, evidence suggests that BCAAs intake can reduce late onset muscle soreness and accelerate the functional recovery of muscles after intense training (Blomstrand & Essén-Gustavsson, 2009; Howatson et al., 2012; Shimomura et al., 2004, 2006).

The current level of knowledge on how protein intake should be organized around resistance exercise is, however, more nuanced than these general benefits suggest. Dietary protein ingestion augments post-exercise muscle protein synthesis (MPS) rates, and the prevailing framework holds that the dose of leucine delivered by a protein meal (the leucine threshold hypothesis) and the resulting plasma leucine profile (the leucine trigger hypothesis) determine the magnitude of the anabolic response (Wilkinson et al., 2023). Applied recommendations derived from this framework typically call for meals providing at least 2–3 g of leucine, which

in practice means roughly 20–25 g of a high-quality protein in close temporal proximity to exercise (Churchward-Venne et al., 2012; Wilkinson et al., 2023). Yet this framework has been challenged: when increasingly complex protein-rich meals and whole foods are studied, the association between ingested or plasma leucine and the magnitude of the postprandial MPS response becomes less coherent (Monteyne et al., 2024). Moreover, the post-exercise response is dose-dependent, since suboptimal doses of whey protein enriched with leucine can match the acute response of a full dose, but only the complete dose sustains elevated synthesis rates over the longer post-exercise window (Churchward-Venne et al., 2012). These dose- and source-dependent effects define how much protein, and of what quality, must actually be consumed after training, which is precisely where practical prescription becomes uncertain for non-animal protein sources.

That uncertainty is amplified by the characteristics of plant proteins. Rapidly digested proteins such as whey produce a pronounced but short-lived increase in circulating essential amino acids, especially leucine, whereas slower-digesting proteins such as casein prolong amino acid release (Berrazaga et al., 2019; Pinckaers et al., 2021; Reidy et al., 2013). Proteins of plant origin generally present lower digestibility and less favorable essential amino acid profiles, which may compromise their effectiveness in stimulating MPS compared to animal proteins (Nichele et al., 2022; Tilman & Clark, 2014), and additional strategies, such as combining plant proteins with other amino acids or carbohydrates, have been proposed to optimise their use in strength training (Machergiany et al., 2025). This concern is particularly relevant for cowpea (*Vigna unguiculata*), a legume whose protein digestibility has been reported between 56% and 72%, well below the 92–100% typical of animal products (Shevkani et al., 2025), with sulfur-containing amino acids acting as the main limitation (Teka et al., 2020). At the same time, cowpea protein contains a total essential amino acid content of approximately 44 g/100 g, exceeding most other legumes, and branched-chain amino acid amounts comparable to egg and milk proteins, which has led to its being proposed as a candidate for plant-based sports foods (Shevkani et al., 2025). Cowpea cultivation is also agronomically undemanding, drought- and heat-tolerant, and associated with markedly lower greenhouse gas emissions than animal protein sources (Shevkani et al., 2025), a point of growing importance given the environmental footprint of diets rich in animal products (Springmann et al., 2018 & Willett et al., 2019). Compounding these source-specific issues, an additional layer of knowledge concerns the food matrix. Current post-exercise protein recommendations were derived almost exclusively from isolated protein sources, yet people ordinarily consume protein within whole foods, where other nutrients and the food structure can modulate digestion, aminoacidemia and the synthetic response (Burd et al., 2019a; Van Vliet et al., 2018). Indeed, the leucine trigger/threshold framework may only be strictly applicable to isolated protein ingestion rather than to whole food sources (Van Vliet et al., 2018). To our knowledge, no study has yet measured post-exercise plasma aminoacidemia after the intake of cowpea immature pods consumed as a whole food matrix at a realistic dietary portion, since existing plant-protein exercise studies have relied on isolates or other protein sources (Monteyne et al., 2021). This is the gap the present study addresses.

Within this gap, the research question is directly relevant to practice. The number of athletes and physically active people following plant-based or plant-forward diets is growing, while sport nutrition guidance remains anchored in isolated animal-derived proteins, leaving practitioners without evidence on whether common, affordable and sustainable legumes can support post-exercise amino acid availability (Berrazaga et al., 2019; Kerkick et al., 2021). The context of this work is the SoilRec4+Health project, which developed a ready-to-eat purée from immature cowpea pods as a sustainable plant-based food. The problem addressed is whether this whole food matrix, served in a typical portion size (150 g, providing an estimated 5 to 6 g of protein), can meaningfully raise plasma BCAA concentrations after a standardized strength training session, or whether its lower digestibility, limiting amino acid profile and low protein dose place it below the anabolic thresholds described in the literature (Burd et al., 2019a; Van Vliet et al., 2018; Wilkinson et al., 2023). Clarifying this has direct practical impact: it informs dosage and food-matrix optimization strategies for plant-based recovery nutrition (Kerkick et al., 2021) and identifies whether realistic portions of legume foods can, or cannot, substitute for concentrated supplements in sports practice. To address this problem, we conducted a repeated-measures cross-over pilot study in which ten healthy young men (26 ± 7.4 years) were examined under four conditions, separated by one week: control (rest), exercise, supplementation, and combined supplementation and exercise. Participants ingested 150 g of the cowpea purée and performed a standardized strength training session comprising bench press, deadlift, lat pull-down and leg press at 75% of one-repetition maximum (3 sets of 8–10 repetitions). Capillary blood samples (~ 120 μ L) were collected at baseline, 45 and 90 minutes post-intervention, and plasma amino acid concentrations were determined by high-performance liquid chromatography with fluorescence detection (HPLC-FLD) after pre-column derivatization with 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate (Cohen, 2003), with data analyzed by repeated-measures MANOVA at a significance level of $p < 0.05$. Given the reported anabolic potential of adequately dosed plant proteins (Monteyne et al., 2021; Nichele et al., 2022), it was hypothesized that cowpea protein supplementation would increase postprandial aminoacidemia and plasma BCAA concentrations following exercise (H1); conversely, considering the typically lower digestibility and less favorable essential amino acid profile of many plant proteins (Gorissen et al., 2018; van Vliet et al., 2015), an alternative hypothesis was that supplementation would not significantly influence plasma BCAA concentrations (H0). This design allowed the isolated and combined effects of the plant-based food matrix and exercise on BCAA kinetics to be tested within participants.

Material & methods

Sample

This investigation was designed as a pilot study with a repeated-measures cross-over design involving ten healthy men (mean $\pm$ SD: 26 $\pm$ 7.4 years; 65 $\pm$ 8.2 kg; 177.5 $\pm$ 6.5 centimeters), free of endocrine cardiovascular diseases or other metabolic diseases through self-reported anamnesis were eligible to participate in this study. Participants performed 4 $\pm$ 1.1 days a week of different types of physical exercise (soccer, strength training, running, volleyball, etc.) with an average weekly duration of 324 $\pm$ 202 minutes, but were not involved in any structured progressive exercise training regimen or following restrictive diets.

The inclusion criteria for the study were defined to ensure homogeneity in the sample. The study included healthy men over the age of 18 who regularly exercised (at least three times a week). The participants had to be available to attend all the experimental sessions and not have suffered any musculoskeletal injuries in the last six months. The exclusion criteria aimed to eliminate factors that could interfere with the results of the study. Individuals diagnosed with metabolic, cardiovascular or musculoskeletal diseases, smokers, people who abuse alcohol, and those taking medication that affects protein metabolism, such as steroids or corticosteroids, were excluded. In addition, participants who were involved in diet or supplementation programs unrelated to the study or who had medical conditions that prevented them from practicing strength exercises were excluded.

The characteristics of the participants are shown in Table 1. Participants were informed about the possible risks of the experimental procedures before providing informed consent and signing the form. Throughout the research, the participants were monitored by three Sports Professionals.

Table 1 - Sample characteristics

Age (years)	Body Mass (Kg)	Stature (Centimeters)	Exercise Time per Week (Minutes)	Weekly Frequency of Physical Exercise (Days)
26 $\pm$ 7,4	65 $\pm$ 8,2	177,5 $\pm$ 6,5	324 $\pm$ 202	4 $\pm$ 1,1

Note: Values are presented as means $\pm$ SD.

Procedures

Participants attended the laboratory on five separate occasions. The first visit involved preliminary screening, which included completing the Medical History Form and the Informed Consent Form. After this, participants were deemed aware and eligible to undergo the one-repetition maximum (1RM) protocol for the bench press, deadlift, lat pull-down, and leg press exercises.

1 RM protocol

All 1RM testing sessions were conducted at the same time of day for each participant, according to their availability. The 1RM protocol began with a general warm-up consisting of a 5-minute walk on a treadmill at 4.5 km/h, followed by general mobility exercises using body weight or resistance bands. The mobility exercises included:

Table 2 - Mobility exercises

SERIES	REPETITIONS	EXERCISE
1	10	Alternating side-to-side squats
1	10	Bodyweight squats
1	10	Narrow-stance squats
1	10	Low row using a resistance band;
1	10	Internal shoulder rotation with a resistance band
1	10	External shoulder rotation with a resistance band.

The 1RM test involved performing various loads until the maximum executable load was reached. Participants were allowed up to 6 attempts per exercise (Chagas et al., 2005; Mayhew et al., 2008), with rest intervals of 3 to 5 minutes between attempts (Mayhew et al., 2008). The test began with a submaximal weight, which was progressively increased with each attempt. The 1RM value was recorded when the participant was unable to complete the movement, with the weight from the previous successful attempt being noted. The test was terminated if there was any deviation in the standard execution of the movement. External assistance was not permitted (Chagas et al., 2005).

Strength Training Protocol

Prior to each ST session, participants performed a light warm-up consisting of a 5-minute walk on a treadmill at 4.5 km/h. The ST protocol, conducted at two different times in the study, involved the exercises bench press, deadlift, lat pull-down, and leg press. Each session consisted of 3 sets of 8-10 repetitions at 75% of 1RM, with 45 seconds of rest between sets and 1 minute between exercises. ST sessions were scheduled at the same time of day for each participant, typically in the morning following an overnight fast (~8:00). If a session was missed, it was immediately rescheduled for the following day.

Study Protocol

One week after the 1RM measurements, participants were subjected to four different conditions across different weeks. For each condition, participants were instructed to avoid strenuous exercise in the 48 hours preceding and to maintain an overnight fast while following their normal dietary patterns throughout the study. The four situations tested were:

- **Control (C):** Participants arrived at the laboratory and remained at rest throughout the protocol.
- **Exercise (E):** Participants performed the ST session based on the previously collected 1RM measurements.
- **Supplementation (S):** Participants ingested 150g of supplementation and remained at rest.
- **Supplementation + Exercise (SE):** Participants ingested 150g of supplement and immediately after ingestion, performed the ST protocol.

All laboratory visits and conditions were separated by 7 days. For each condition, capillary blood samples (~120 µL) were collected at different times: baseline (pre = 0), 45 minutes post-intervention (post 1), and 90 minutes post-intervention (post 2), using an Accu-Chek Safe-T-Pro-Plus lancing device. The samples were collected into capillary tubes containing heparin and stored in Eppendorf microtubes (1.5 mL) at -20°C for subsequent total amino acid analysis. The study design is illustrated in the following figure:

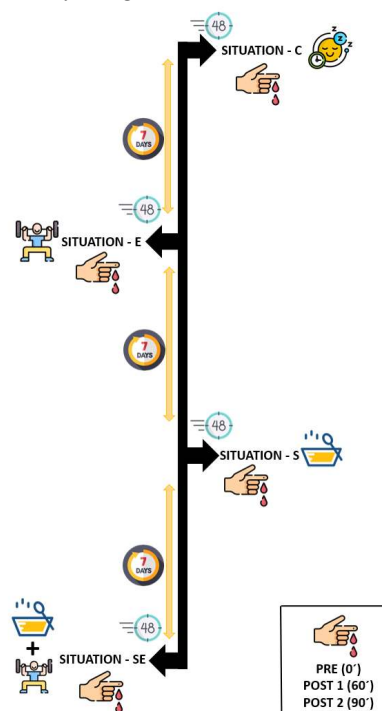


Figure 1. Experimental design. There was a 7-day interval between each situation, and in the last 48 hours the participants did not perform any strenuous exercise.

Source: Authors

Cowpea Purée Supplement: Characterization and Nutritional Composition

The immature pods of cowpeas (*Vigna unguiculata* (L.) Walp.) are the main source of plant protein in the supplement used. According to (Passão et al., 2022), who characterized the raw material as part of the same research project (SoilRec4+Health), the immature pods have a crude protein content of approximately $27.48 \pm 1.05\%$ on a dry matter basis. However, it is important to note that this value refers to the dehydrated pod matrix. The supplement administered in the present study was a ready-to-eat puree prepared from these fresh immature pods, which also contained garlic, olive oil, and salt. Considering the high moisture content characteristic of developing pods, which according to (Cruz et al., 2019) can range from values close to 97% in the early stages to about 18% near physiological maturity, it is estimated that the fresh pods used had a moisture content of around 85%, resulting in a protein concentration of approximately 4.1 g per 100 g of raw pod. Consequently, for a 150-g serving of the puree (which includes non-protein ingredients) the total protein content is estimated at 1816-----

approximately 5–6 g. This value is substantially lower than the 15–18 g previously estimated for raw pods alone, and this discrepancy should be considered when interpreting the study's results regarding postprandial aminoacidemia.

Amino Acid Determination

Plasma amino acid concentrations were determined by High-Performance Liquid Chromatography with Fluorescence Detection (HPLC-FLD). Blood samples (25 μ L) were processed by adding 5 mL of 6 M HCl. The tubes were hermetically sealed and hydrolysis was carried out at 110°C for 24 h. Samples were then cooled to room temperature and the pH was adjusted to 2.0 with NaOH. Each sample was transferred to a 50 mL volumetric flask, to which 1 mL of internal standard solution (L-norvaline, 5 mM) was added, and the volume was completed to 50 mL. A 1 mL aliquot was subsequently filtered through a 0.22 μ m membrane and stored for further processing. All samples were derivatized pre-column using 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate (AQC), according to the procedure described by (Cohen, 2003) with minor modifications. In brief, 5 μ L of sample was mixed with 35 μ L of borate buffer (0.2 M sodium borate, 5 mM disodium calcium EDTA, pH 8.8) and vortexed for 30 s. Then, 10 μ L of AQC reagent (3 mg mL⁻¹ in acetonitrile) was added and immediately mixed for 30 s. The vial was hermetically sealed, heated at 50°C for 10 min, and placed in the autosampler (maintained at 10°C).

Chromatographic separation was performed on an ACE 5 C18 column (5 μ m, 150 mm $\times$ 4.6 mm i.d.) (Advanced Chromatography Technologies Ltd, Aberdeen, UK). The mobile phases used were 140 mmol L⁻¹ sodium acetate, 17 mmol L⁻¹ triethylamine, 1 mmol L⁻¹ EDTA in water, pH 4.95 (mobile phase A), acetonitrile/distilled water (60:40 v/v) (mobile phase B), and water (mobile phase C). The flow rate and injection volume were 1 mL min⁻¹ and 5 μ L, respectively. The linear gradient scheme (t in min; %B; %C) was as follows: (0; 0%; 0%), (40; 33%; 7%), (48; 40%; 0%), and (53.5; 100%; 0%). The column was then re-equilibrated for 10 min before the next injection. Analyte identification was carried out on a Thermo Scientific Dionex UltiMate 3000 Series system (Thermo Fisher Scientific Inc., Waltham, MA, USA) equipped with a quaternary pump RS, an autosampler WPS-3000RS (maintained at 10°C), a column compartment TCC-3000RS (maintained at 35°C), and a fluorescence detector FLD-3400RS (excitation and emission wavelengths set to 250 and 395 nm, respectively). Data acquisition and processing were performed using Chromeleon software, Version 7.2 (Thermo Fisher Scientific Inc., Waltham, MA). Amino acids were identified by comparison with authentic standards.

Statistical analysis

For statistical analysis, the SPSS (Statistical Package for the Social Sciences) software was used with a significance level of $p < 0.05$. Descriptive statistics were performed, including mean, standard deviation, and percentage. Normality was assessed using the Kolmogorov-Smirnov test. Data skewness and kurtosis were evaluated to identify and exclude outliers. Considering the normal distribution of variables, repeated measures MANOVA was used to compare different groups and time points.

Results

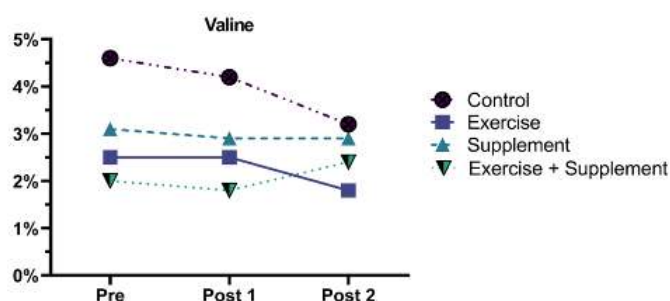


Figure 2 - Blood percentages of valine, in the 4 situations at pre, post 1 and post 2 ($p > 0.05$).

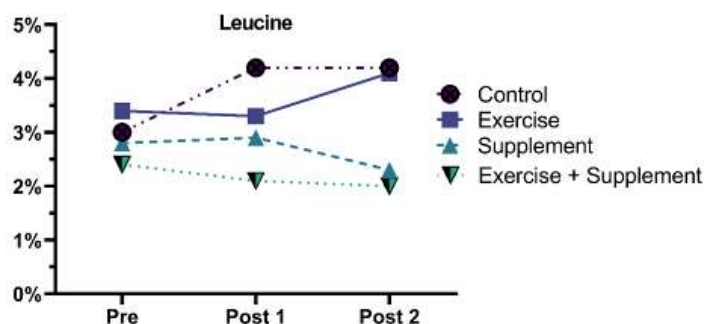


Figure 3 - Blood percentages of leucine in the 4 situations at pre, post 1 and post 2 ($p < 0.05$).

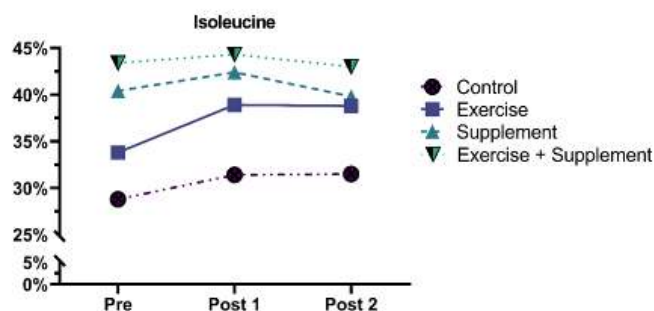


Figure 4 - Blood percentages of isoleucine in the 4 situations, at pre, post 1 and post 2 ($p < 0.05$).

The values for blood BCAAs percentages are shown in Figures 2 to 4. Leucine levels exhibited significant differences between groups over time ($p = 0.036$, $\eta^2 p = 0.259$), indicating distinct variation patterns across experimental conditions. In the Control Condition (C), a peak of 4.2% was observed at post 1, remaining stable at post 2. In the Exercise Condition (EC), the peak was reached at post 2 (4.1%), while in the Supplementation Condition (SC), the highest level was recorded at post 1 (2.9%). Conversely, in the Supplementation + Exercise Condition (SEC), leucine levels showed a decreasing trend across time points, with values of 2.4%, 2.1%, and 2.0%, respectively. For isoleucine, percentages remained stable over time but differed significantly between the Control Condition (28.8%; 31.4%; 31.5%) and the Supplementation + Exercise Condition (43.4%; 44.3%; 43.0%) ($p = 0.020$, $\eta^2 p = 0.292$).

Dicussion

The results of this study showed that supplementation with vegetable protein derived from cowpea pods, combined with strength training, did not lead to a significant increase in plasma concentrations of BCAAs such as leucine, isoleucine and valine. Leucine showed different peaks between the groups, with a lower concentration in the group that combined supplementation and exercise (SE) after 45 and 90 minutes. This finding can be explained by the lower digestibility and absorption of plant proteins compared to animal proteins such as whey protein, which is known to induce a rapid and pronounced increase in postprandial leukaemia (Boirie et al., 1997; Pennings et al., 2011). Leucine is an essential amino acid that acts as a key signalling for muscle protein synthesis (MPS), and its availability in plasma is crucial for maximising the post-exercise anabolic response (Anthony et al., 2001; Garlick, 2005). Therefore, the lower leucine concentration observed in the SE group suggests that this particular plant protein supplement may not stimulate MPS as potently as some animal-based proteins, such as whey, are reported to do in the literature.

Recent research by (Monteyne et al., 2021) supports this notion, as they found that mycoprotein, a fungal-derived protein, elicited a comparable anabolic response to milk protein. However, they also noted that the amino acid profile and digestibility of mycoprotein were more favorable than many other plant proteins, emphasizing the importance of protein source selection. This suggests that not all plant proteins are created equal, and some may be more effective than others in stimulating MPS.

Isoleucine, on the other hand, showed significant differences between the control group (C) and the SE group, with higher concentrations in the SE group. This increase may be related to the metabolism of BCAAs during exercise, where isoleucine is oxidised to provide energy, especially under conditions of fasting or intense physical exertion (Harper et al., 1984; Shimomura et al., 2004). However, the increase observed was modest, which may indicate that the vegetable protein used was not able to provide sufficient amounts of isoleucine to sustain a significant anabolic response. Previous studies have highlighted that supplementation with BCAAs can improve muscle recovery and reduce protein breakdown during exercise, but effectiveness depends on the quality and quantity of amino acids supplied (Churchward-Venne et al., 2014; Shimomura et al., 2004). Thus, supplementation with vegetable protein may require adjustments in dosage or combination with other amino acids to optimise its effects.

Valine, another essential BCAA, showed no significant variations between groups or over time. This result may reflect the lower metabolic priority of valine compared to leucine and isoleucine in the context of muscle protein synthesis. While leucine is the main regulator of MPS, valine has a more secondary role, acting mainly as an energy substrate during exercise (Harper et al., 1984; Shimomura et al., 2004). The absence of significant changes in valinaemia may indicate that the vegetable protein used was not able to sufficiently raise plasma levels of this amino acid, or that its oxidation during exercise compensated for any post-intake increase. This finding reinforces the idea that the quality of the protein, including its amino acid profile, is a determining factor in the effectiveness of post-exercise supplementation (S. H. M. Gorissen et al., 2018; van Vliet et al., 2015). The combination of protein supplementation and strength exercise did not result in significant increases in BCAA concentrations, which could be attributed to the nature of the plant protein used. Plant proteins, such as those derived from cowpeas, tend to have slower digestion and a less complete amino acid profile compared to animal proteins such as whey (Boirie et al., 1997; S. H. Gorissen et al., 2020). Studies show that the speed of protein digestion and absorption is a critical factor for the post-exercise anabolic response, with fast-absorbing

proteins such as whey being more effective at stimulating MPS (Pennings et al., 2011; Tang et al., 2009). In addition, the lower leucine concentration observed in the SE group may limit the activation of intracellular signalling pathways, such as the mTOR pathway, which is essential for muscle protein synthesis (Anthony et al., 2001; Garlick, 2005). Furthermore, (Burd et al., 2019b) emphasized the role of protein timing and distribution in optimizing muscle protein synthesis. Their research indicated that the consumption of protein in multiple doses throughout the day, rather than a single large dose, could enhance the anabolic response, particularly when using plant-based proteins. This strategy could potentially compensate for the slower digestion and absorption rates of plant proteins, ensuring a more sustained release of amino acids into the bloodstream.

The environmental and health benefits of plant-based proteins have been widely recognized. Springmann et al., (2018) conducted a comprehensive analysis of the environmental impact of different dietary patterns and found that plant-based diets were associated with significantly lower greenhouse gas emissions, land use, and water use compared to diets rich in animal products. This underscores the importance of developing effective strategies to incorporate plant proteins into sports nutrition, not only for their potential health benefits but also for their sustainability.

Despite the limitations observed, the results suggest that plant protein supplementation can play a complementary role in nutritional strategies aimed at muscle recovery. Recent studies indicate that combining plant proteins with carbohydrates or supplementing with BCAAs can improve the anabolic response, especially in populations that follow plant-based diets (S. H. Gorissen et al., 2020; Kerksick et al., 2021). In addition, the inclusion of plant proteins in the diet can bring additional benefits, such as reducing environmental impact and promoting cardiovascular health, which justifies exploring strategies to optimise their use in the sports context (Tilman & Clark, 2014; Willett et al., 2019). A significant methodological limitation of this study is the absence of controlled dietary standardization or a comprehensive assessment of the participants' habitual protein intake. The lack of this data means that variability in baseline nutritional status, particularly protein consumption in the hours or days preceding the experimental trials, could have confounded the observed plasma amino acid responses, making it difficult to isolate the specific effect of the cowpea supplement itself.

This study has some limitations that should be acknowledged. First, the small sample size ($n=10$) restricts the statistical power and generalizability of the findings. Second, the absence of controlled dietary standardization means that variability in participants' habitual protein intake could have confounded the observed plasma amino acid responses. Third, it is important to note that the nutritional characterization of the cowpea protein source used in this study (Passão et al., 2022) was performed on the raw immature pods, which contain approximately 27% protein. However, the final supplement administered to the participants was a purée that included other ingredients (garlic, olive oil, and salt), which likely diluted the overall protein concentration of the dose. The absence of a precise nutritional analysis of the final purée matrix represents a limitation, as the exact protein and amino acid content ingested cannot be confirmed. Consequently, the estimated protein content of approximately 5–6g per 150g serving is substantially lower than the 15–18g that would be expected from the raw pods alone, and this discrepancy should be considered when interpreting the results regarding postprandial aminoacidemia. In light of the results, the data supports the null hypothesis (H_0), as no statistically significant differences in BCAA appearance were found between the supplemented and control conditions. This outcome is likely due to the food matrix effect of the purée, which may have slowed digestion, and the specific protein dose used (5-6g), which may be below the threshold required to induce a robust increase in plasma aminoacidemia in trained men.

Conclusions

The central takeaway of this pilot study is that cowpea purée supplementation, at a portion providing an estimated 5 to 6 g of protein, did not elicit a significant post-exercise increase in plasma BCAA appearance kinetics, whether ingested alone or combined with strength training. The null hypothesis was supported: no significant differences in BCAA appearance were observed between the supplemented and control conditions, leucine decreased over time in the combined condition, isoleucine differed between conditions without an anabolic pattern, and valine remained unchanged. The implication of this answer is that neither the dose nor the food matrix alone explains the outcome: the high-moisture culinary matrix dilutes the protein below the anabolic range, and the slower digestion of plant proteins flattens the aminoacidemic curve. This shows that recommendations derived from isolated protein sources cannot be transferred directly to whole foods, and that dose, quality and matrix must be evaluated jointly.

Regarding significance for practice and business, athletes relying on typical portions of cowpea-based dishes after exercise should combine them with concentrated protein sources or larger servings, and product development should focus on increasing the purée's protein density and applying processing technologies such as fermentation, which improve the digestibility of cowpea amino acids. These are low-cost, testable pathways toward a locally producible, sustainable recovery product for a growing market of plant-based athletes. Future work should include randomized controlled trials with larger samples, standardized diets, direct nutritional analysis of the final product, and dose-response comparisons with animal-based reference proteins. If these confirm that an optimized cowpea matrix reaches the anabolic range, the outcome will be a locally producible, sustainable and affordable recovery food for sports nutrition.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: During the preparation of this work the author(s) used DeepL Translator (web version) in order to translate the manuscript text from Portuguese to English. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication. Connected Papers was used to support the literature search; it did not generate, edit or analyse any manuscript content.

Conflicts of interest: The authors declare no conflicts of interest.

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