Effects of House Cricket (*Acheta domesticus*) Supplementation on Muscle Recovery following an Exercise-Induced Pain in Recreationally Active Males

by

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House crickets (Acheta domesticus), rich in protein, may aid muscle recovery, particularly after unaccustomed eccentric exercise, which typically causes pain and impairs muscle function. This study investigated the effects of house cricket supplementation on muscle recovery following eccentric drop jump exercise. Thirty-six recreationally active males performed 100 drop jumps to induce muscle damage and pain and were then supplemented with house cricket powder (CRI; n = 12), whey protein isolate (WHE; n = 12), or isocaloric maltodextrin (CON; n = 12). Supplements were adjusted to ensure a daily protein intake of 1.4 g/kg body weight. Muscle pain (visual analogue scale, VAS), maximum strength (isokinetic knee extension [KEX], flexion [KFX], and isometric knee extension [IKE]), and explosive power (countermovement jump [CMJ], and squat jump [SQJ]), were evaluated at baseline, and at 10 min, 24, 48, and 72 h post-exercise. The exercise significantly increased VAS scores (~5.3 of 10), and reduced KEX (~16%), KFX (~6%), IKE (~20%), CMJ (~14%), and SQJ (~14%) performance. Both CRI and WHE significantly improved maximum strength recovery (KEX and IKE) compared to CON (p < 0.001), likely due to their protein content. However, neither supplement enhanced explosive power recovery (CMJ and SQJ), possibly due to persistent pain acting as a protective mechanism limiting explosive contractions. In conclusion, house cricket supplementation shows promise as a sustainable alternative to conventional protein supplements for improving maximum strength recovery following an unaccustomed eccentric exercise.

***Keywords**: insect; protein; strength; muscle soreness; eccentric exercise*

Introduction

Engaging in unaccustomed eccentric exercise is known to cause muscle pain (soreness), which typically lasts for several days and can impair normal muscle function (Lewis et al., 2012). On the other hand, protein-rich animal supplements have been shown to improve muscle functions (Choi et al., 2023; Vangsoe et al., 2018) and accelerate recovery from exercise-induced pain (Abbott et al., 2019; Buckley et al., 2010; Cockburn et al., 2008). Specifically, insect-based supplements have been found to increase mammalian target of rapamycin complex-1 (mTORC1) signalling (Lanng et al., 2023) and muscle protein synthesis (MPS) (Hermans et al., 2021). These mechanisms have been associated with increases in fat-free mass (Vangsoe et al., 2018) and improvements in muscle strength (Choi et al., 2023). Collectively, these findings suggest that insects have the potential to serve as effective supplements for aiding muscle recovery from exercise-induced pain.

Muscle pain caused by unaccustomed eccentric exercise is primarily attributed to damage to structural proteins of muscle fibres. Additional movements increase intramuscular pressure, stimulating pain receptors (Cheung et al., 2003; Newham et al., 1988) and subsequently impairing muscle function (Vila-Chã et al., 2012). This pain

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triggers muscle inhibition as a protective mechanism to prevent further damage, resulting in reduced force production (Racinais et al., 2008). Depending on the intensity of the exercise, muscle pain typically peaks between 24 and 72 hours and diminishes within 5–7 days (Cheung et al., 2003; Lewis et al., 2012). Numerous studies have demonstrated the benefits of protein-rich animal products in aiding recovery. Supplements such as milk, whey, and casein have been shown to improve the recovery of isokinetic strength (Cockburn et al., 2008), isometric strength (Buckley et al., 2010; Cooke et al., 2010), and jumping ability (Abbott et al., 2019) following exercise-induced pain. Additionally, a few studies have associated strength improvements with enhanced pain recovery (Abbott et al., 2019; Draganidis et al., 2017; Hirose et al., 2013). In short, protein-rich animal products can accelerate recovery from pain and improve muscle function following unaccustomed eccentric exercise.

Insects are an excellent source of protein and are widely regarded as a sustainable protein alternative due to their low environmental impact (Oonincx and de Boer, 2012). House crickets (*Acheta domesticus*; Orthoptera: Gryllidae), for example, provide over 70 g of protein per 100 g dry weight, along with lipids, fibres, vitamins, and minerals (Brogan et al., 2021), all of which are important for maintaining bodily function. In the context of exercise, house cricket supplementation has shown efficacy in maintaining the body's protein equilibrium (Lanng et al., 2023). Moreover, a recent review identified several benefits of insect consumption for exercise, including improvements in performance, body composition, and metabolism (Vanlin et al., 2024). These benefits include increases in strength (Choi et al., 2023), enhanced time-to-fatigue (Lee et al., 2019), greater muscle mass (Vangsoe et al., 2018), reductions in fat mass (Son et al., 2018), and improved lipid and energy metabolisms (Ryu, 2014). Such outcomes have been associated with the regulatory role of protein content in insects. Additionally, insect supplementation has been shown to elevate blood amino acid concentrations (Hermans et al., 2021; Lanng et al., 2023), which can stimulate mTORC1 signalling (Lanng et al., 2023) and muscle protein synthesis (MPS) (Hermans et al., 2021). Collectively, these properties suggest that insect protein could support the recovery of muscle function following exercise-induced pain.

Most protein supplements are derived from dairy products, which are unsuitable for lactose-intolerant individuals (Shah and Jelen, 1991) and less sustainable (González-García et al., 2013). While previous studies have highlighted numerous benefits of insect consumption for exercise, none have specifically examined the effects of house cricket supplementation on muscle recovery. Hence, this study aimed to (i) determine whether house cricket supplementation could alleviate muscle pain and restore muscle function following exercise-induced pain, and (ii) compare the effects of house cricket and whey protein on muscle function recovery. It was hypothesised that house cricket supplementation would support muscle function recovery similarly to whey protein. House crickets offer a promising alternative protein source to address the growing demand for protein, especially in the field of sports and exercise.

Methods

Participants

The sample size for this study was determined using G*Power software (G*Power, Germany). Given the study's design, which included three groups with one pre-test followed by four post-tests, a repeated-measures within-between-group ANOVA was selected. Assuming a medium effect size and 85% power, the required sample size was calculated to be 30 participants. However, to account for potential dropouts, 39 male participants were recruited.

Thirty-nine healthy, recreationally active (as confirmed by GPAQ; exercising 2–5 hours per week) were assigned to consume one of the following supplements: house cricket powder (CRI; age: 22.33 ± 2.42 years, body height: 172.83 ± 3.71 cm, body mass: 68.82 ± 11.03 kg, BMI: 23.00 ± 3.38 kg/m^2), whey protein isolate (WHE: age: 21.92 ± 2.46 years, body height: 171.58 ± 7.02 cm, body mass: 68.83 ± 6.69 kg, BMI: 23.47 ± 2.92 kg/m^2), or maltodextrin as a control (CON; age: 21.25 ± 2.22 years, body height: 171.00 ± 4.15 cm, body mass: 68.50 ± 5.61 kg, BMI: 23.48 ± 2.50 kg/m^2). Exclusion criteria included individuals with health conditions or medication use that could interfere with the research, smoking, participation in structured resistance exercise more than twice a week, and relevant food allergies. Participants were informed about the study procedure and potential risks, such as minor rashes or muscle soreness, before obtaining their informed consent. Two participants did not complete the experiment: one in the CRI group experienced an allergic reaction, and one in the CON group withdrew. Additionally, one participant from the WHE group failed to adhere to the protocol and was excluded from the data analysis. Ultimately, 36 participants were included in the final analysis (n = 12 each).

Measures

Maximum strength was assessed using an isokinetic dynamometer (Humac Norm, USA). Isokinetic peak torque of the dominant leg was measured through five repetitions of concentric knee extension (KEX) and flexion (KFX) at an angular velocity of 60°/s. Maximum isometric voluntary knee extension (IKE) was evaluated through three sets of isometric contraction at a 60° knee angle. Participants were instructed to exert maximum effort during each test, with a 2-min rest interval between tests, following the protocol described by Chan et al. (2020). Visual feedback on force generation and verbal encouragement were provided to ensure maximum effort.

Explosive contractions were assessed using countermovement jumps (CMJs) and squat jumps (SQJs) on a force plate (Hawkin Dynamics, USA). For the CMJ test, participants started from a standing position with fully extended knees and performed a downward countermovement (approximately 90°) before jumping vertically as high as possible (Hilkens et al., 2021). The SQJ test was performed from a squat position (approximately 90°), without any counter-movement. Each test was performed three times, with a one-minute rest interval between attempts. Verbal encouragement was provided to ensure participants exerted maximum effort.

Design and Procedures

Experimental Design

This study employed a double-blind, randomized controlled trial to assess the effects of house cricket and whey supplementation on muscle pain and function over 72 h following an exercise-induced muscle damage protocol. Participants were randomly and evenly assigned to one of the three groups: house cricket powder (CRI), whey protein isolate (WHE), or maltodextrin as a control (CON). All study procedures were conducted at the Faculty of Sports and Exercise Science, in accordance with the Declaration of Helsinki, and approved by the research ethics committee of the University of Malaya, Kuala Lumpur, Malaysia (protocol code: UM.TNC2/UMREC_2337; approval date: 17 February 2023).

All participants underwent a familiarisation session one week before the experiment. On the day of the trial, baseline outcome measures were taken following a warm-up. Muscle pain was then induced via 100 drop jumps. Outcome measures were subsequently recorded at 10 min, and again at 24, 48, and 72 h post-exercise. Supplements were consumed immediately after the exercise protocol, and again at 24, 48, and 72 h post-exercise. This supplementation schedule is supported by previous research demonstrating the effectiveness of whey protein for muscle recovery (Brown et al., 2018) (Figure 1).

Physical Activity and Dietary Control

Participants recorded their diets before and throughout the experimental period and were encouraged to maintain consistent meal patterns each day. Food intake was analysed using Nutritionist Pro (Axxya Systems, USA) software. To enhance compliance, participants received daily reminders via messaging. No significant differences in nutrient intake were observed between groups either before or during the experiment (Table 1). Throughout the experimental period, participants were prohibited from consuming prescription or over-the-counter drugs, alcohol, or caffeine and were required to refrain from vigorous physical activity.

Supplementation

All the drinks were natural in taste and colour and were prepared by a volunteer not affiliated with the study. The drinks were prepared by mixing 400 mL of water with the respective powders: maltodextrin (MyProtein, UK), house cricket powder (Thailand Unique, Thailand), and whey protein isolate (Purefit, Malaysia). For every 100 g, the house cricket powder provided 405 kcal (10 g carbohydrate, 80 g protein, 5 g fat), the whey protein isolate supplied 398 kcal (6 g carbohydrate, 80 g protein, 6 g fat) and the maltodextrin offered 400 kcal (100 g carbohydrate, 0 g protein, 0 g fat).

Based on the participants' recorded diet before the experiment, CRI and WHE supplementation were individually adjusted to provide 1.4 g of protein per kg of body weight (BW) daily, while the CON group consumed maltodextrin matched isocalorically to the house cricket powder. On average, the CRI group received ~22 g of protein (27.5 g of house cricket, 111.37 kcal) per serving, the WHE group received ~26 g of protein (32.5 g of whey protein isolate, 129.35 kcal) per serving, and the CON group received ~27.4 g of carbohydrate (109.6 kcal) per serving from maltodextrin. An exit survey was conducted to assess the effectiveness of blinding. Out of the 36 participants, 22 (61.11%) were unaware of what they had consumed, six (16.67%) guessed incorrectly, while eight (22.22%) correctly identified their supplement.

Exercise-Induced Pain Protocol and Pain Measurement

Muscle pain was induced using five sets of 20 drop jumps. Participants dropped from a 60-cm step, landed with both knees bent approximately 90°, and then jumped vertically as high as possible before landing again with both legs. A 10-s rest interval was allowed between each jump, with a two-minute rest interval between sets (Miyama and Nosaka, 2004). To ensure consistent maximum effort, participants received verbal encouragement throughout the protocol.

Muscle pain perception was assessed using a visual analogue scale (VAS). Participants performed a 90° knee-angle squat held for 3 s before rating their perceived muscle pain on the VAS, which ranged from 0 mm (no pain) to 100 mm (worst imaginable pain).

Statistical Analysis

Data were analysed using SPSS version 25 (IBM Corp., USA) and expressed as mean ± standard deviation. Normality and homogeneity were assessed using the Shapiro-Wilk and Levene's homogeneity tests, respectively. Baseline differences were evaluated using a one-way ANOVA. Changes in outcome measures were analysed with a two-way ANOVA, accounting for two independent factors: time (Baseline, 10 min, 24 h, 48 h, and 72 h) and group (CON, WHE, CRI). Group-time interaction and time effects were reported as ($F_{\text{df treatment, df error}}$ = F statistic, *p*-value, η^2). Significant main effects were further analysed with Fisher's LSD. Effect sizes (ES) between groups were calculated using Cohen's *d*, with thresholds of 0.2 (small), 0.5 (medium), and 0.8 (large). The main ES was determined via eta squared analysis with 0.01 (small), 0.06 (medium), and 0.14 (large). Correlations between VAS and muscle function were assessed using the Pearson coefficient, while a *p*-value of below 0.05 was considered statistically significant.

Results

There were no significant baseline differences among the groups, for any of the outcome measures (VAS, KEX, KFX, IKE, CMJ, SQJ) ($p > 0.05$).

Muscle Pain (VAS)

There was no significant group x time interaction ($F_{8,\ 132} = 1.47$, $p = 0.459$, $\eta^2 = 0.019$), however, a significant time effect was observed ($F_{3.06,\ 101.12} = 113.62$, $p < 0.001$, $\eta^2 = 0.759$). Pain perception increased following the exercise protocol and persisted in all groups until 72 h post-exercise ($p < 0.05$ compared to baseline).

Isokinetic Knee Extension (KEX)

There was a significant group x time interaction ($F_{8,132} = 5.91$, $p < 0.001$, $\eta^2 = 0.079$) and a significant time effect ($F_{3.49,\ 115.16} = 97.75$, $p < 0.001$, $\eta^2 = 0.651$). All groups showed a significant reduction in KEX at 10 min post-exercise ($p < 0.05$). By 24 h, the CON group showed further decline, while both CRI and WHE groups began to recover (ES = 0.4 compared to CON). At 48 h, the WHE group showed a significant improvement compared to the CON group ($p = 0.032$), while the CRI group displayed a recovery trend ($p = 0.094$, ES = 0.8) relative to the CON group (Figure 2). The results are presented in Table 2 and illustrated in Figure 2.

Isokinetic Knee Flexion (KFX)

There was no significant group x time interaction ($F_{8,\ 132} = 0.56$, $p = 0.804$, $\eta^2 = 0.022$), however, a significant time effect was observed ($F_{3.26,\ 107.47} = 11.841$, $p < 0.001$, $\eta^2 = 0.213$). Following the exercise, all groups experienced a significant decrease in KFX ($p < 0.05$).

Isometric Knee Extension (IKE)

There was significant group x time interaction ($F_{8,132} = 3.641$, $p = 0.001$, $\eta^2 = 0.042$) and a significant time effect ($F_{2.68,\ 88.42} = 118.392$, $p < 0.001$, $\eta^2 = 0.689$). IKE declined significantly following the exercise protocol across all groups ($p < 0.05$). By 24 h, CRI (ES = 0.29 vs. CON) and WHE (ES = 0.54 vs. CON) groups showed improvements, while the CON group experienced a further decline. Full recovery was observed in all groups by 72 h (Figure 3).

Table 1. Average daily food intake of the participants before and during the experiment.

	CRI (n = 12)		WHE (n = 12)		CON (n = 12)		*p*-value
	Before	During	Before	During	Before	During	Interaction
Energy (kcal)	1765 ± 187	1721 ± 229	1778 ± 465	1626 ± 325	1702 ± 272	1854 ± 335	0.24
Fat (g)	56 ± 18	41 ± 16	54 ± 21	47 ± 15	56 ± 17	63 ± 30	0.15
Fat (g/kg)	0.8 ± 0.3	0.6 ± 0.3	0.7 ± 0.2	0.6 ± 0.2	0.8 ± 0.2	0.9 ± 0.5	0.15
Protein (g)	73 ± 8	68 ± 9	70 ± 21	63 ± 15	67 ± 13	72 ± 7	0.13
Protein (g/kg)	1.0 ± 0.1	1.0 ± 0.2	1.0 ± 0.2	0.9 ± 0.2	1.0 ± 0.1	1.0 ± 0.1	0.12
CHO (g)	236 ± 42	266 ± 55	252 ± 69	236 ± 44	229 ± 35	244 ± 38	0.32
CHO (g/kg)	3.5 ± 0.8	3.8 ± 0.6	3.5 ± 0.8	3.3 ± 0.7	3.3 ± 0.5	3.5 ± 0.5	0.42

Note: Values are expressed as mean ± SD (n = 36). Data were analysed with two-way ANOVA; significance was set at p < 0.05

Table 2. Outcome measures at all time points.

	CRI (n = 12)	WHE (n = 12)	CON (n = 12)
Visual analogue scale (cm)			
Baseline	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
10 min	5.2 ± 1.7 [a,e]	5.3 ± 1.4 [a,d,e]	5.3 ± 1.8 [a,e]
24 h	5.0 ± 1.6 [a,e]	4.1 ± 1.8 [a,e]	5.6 ± 1.5 [a,e]
48 h	4.9 ± 1.6 [a,e]	3.6 ± 1.4 [a,b,e]	5.2 ± 1.9 [a,e]
72 h	2.6 ± 1.9 [a,b,c,d]	1.3 ± 1.1 [a,b,c,d]	2.4 ± 1.9 [a,b,c,d]
Isokinetic knee flexion (Nm)			
Baseline	132 ± 14	137 ± 24	127 ± 14
10 min	124 ± 13 [a,e]	129 ± 23 [a,e]	121 ± 14 [a,e]
24 h	123 ± 12 [a]	127 ± 21 [a,e]	119 ± 14 [a,e]
48 h	129 ± 12	128 ± 26 [a,e]	120 ± 14 [a,e]
72 h	130 ± 15 [b]	135 ± 22 [b,c,d]	126 ± 14 [b,c,d]
Countermovement jump (cm)			
Baseline	33.4 ± 4.2	33.4 ± 4.0	32.6 ± 4.2
10 min	29.5 ± 3.9 [a,d,e]	28.9 ± 4.2 [a,d,e]	28.4 ± 4.5 [a,c,d,e]
24 h	30.5 ± 3.4 [a,d,e]	30.1 ± 4.2 [a,e]	29.4 ± 4.5 [a,e]
48 h	31.9 ± 3.7 [a,b,c]	30.9 ± 4.2 [a,b,e]	29.8 ± 5.4 [a,b,e]
72 h	33.3 ± 4.1 [b,c,d]	32.5 ± 4.6 [a,b,c,d]	31.6 ± 4.8 [a,b,c,d]
Squat jump (cm)			
Baseline	27.0 ± 4.1	27.6 ± 3.7	26.3 ± 4.0
10 min	23.2 ± 3.9 [a,c,d,e]	23.8 ± 3.5 [a,d,e]	22.9 ± 3.9 [a,e]
24 h	24.2 ± 3.9 [a,b,d,e]	24.5 ± 3.7 [a,e]	23.3 ± 3.5 [a,e]
48 h	25.6 ± 3.4 [a,b,c,e]	25.3 ± 3.9 [a,b,e]	23.8 ± 3.9 [a,e]
72 h	26.6 ± 4.2 [b,c,d]	26.7 ± 3.5 [a,b,c,d]	25.3 ± 4.1 [a,b,c,d]

Note: Data were presented as mean ± SD and were analysed with two-way ANOVA. Significance was set at p < 0.05. [a] significant difference with baseline, [b] significant difference with 10 min, [c] significant difference with 24 h, [d] significant difference with 48 h, [e] significant difference with 72 h. CRI: house cricket powder; WHE: whey protein isolate; CON: maltodextrin powder

Table 3. Correlation coefficients (r) between the pain score and muscle function.

Muscle Function	Correlation (r)		
	CRI (n = 12)	WHE (n = 12)	CON (n = 12)
Isokinetic knee extension (Nm)	−0.81	−0.86	−0.94*
Isokinetic knee flexion (Nm)	−0.86	−0.91*	−0.93*
Isometric knee extension (Nm)	−0.79	−0.89*	−0.90*
Countermovement jump (cm)	−0.83	−0.99*	−0.94*
Squat jump (cm)	−0.83	−0.99*	−0.97*

*Note: Data were analysed with Pearson correlation analysis. * $p < 0.05$ represents significant value*

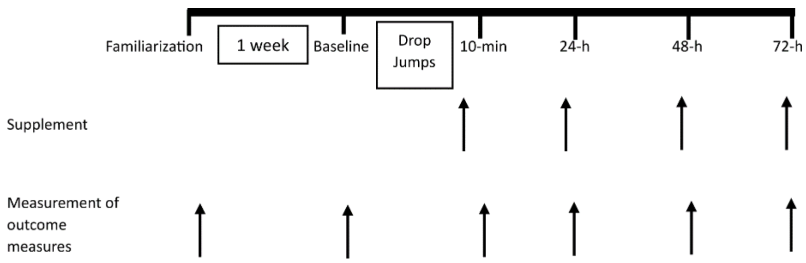

Figure 1. Timeline of the study.

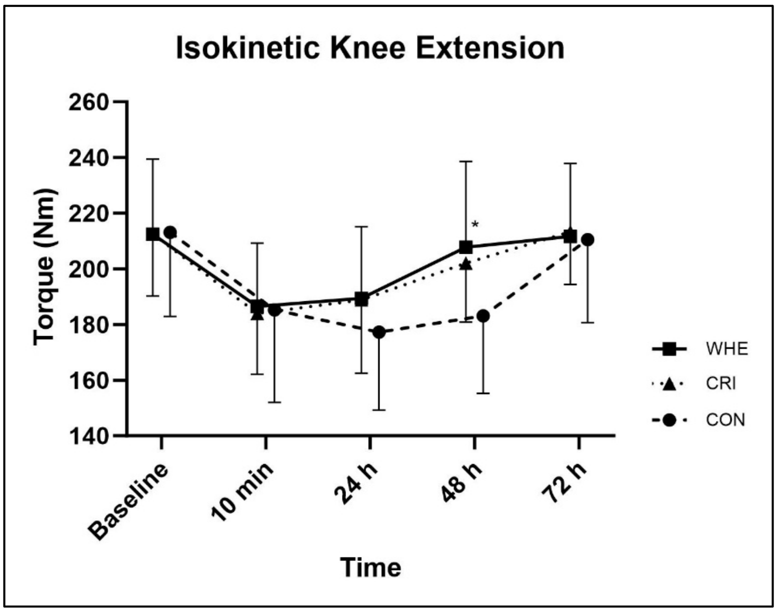

Figure 2. Isokinetic knee extension torque changes over time presented as mean ± SD (n = 36).
*Note: Two-way ANOVA indicated a significant interaction (Group x Time interaction, p < 0.001). * Significant difference with CON. CRI: house cricket powder; WHE: whey protein isolate; CON: maltodextrin powder*

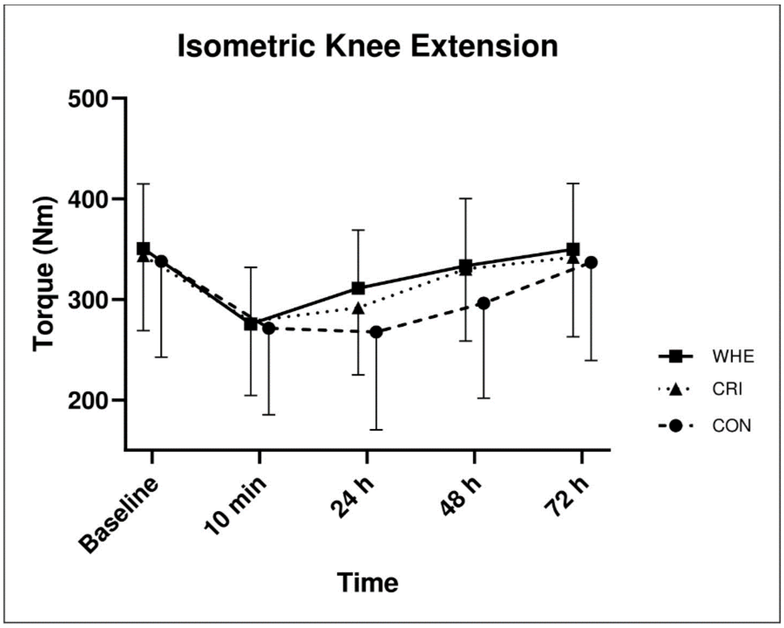

Figure 3. Isometric knee extension torque changes over time presented as mean ± SD (n = 36).
Note: Two-way ANOVA indicated a significant interaction (Group x Time interaction, p = 0.001). CRI: house cricket powder; WHE: whey protein isolate; CON: maltodextrin powder

Countermovement Jump (CMJ)

There was no significant group x time interaction ($F_{8, 132} = 0.509$, $p = 0.848$, $\eta^2 = 0.009$), however, a significant time effect was observed ($F_{3.07, 101.27} = 62.26$, $p < 0.001$, $\eta^2 = 0.598$). Jump height was significantly reduced after the exercise protocol ($p < 0.05$).

Squat Jump (SQJ)

There was no group x time interaction ($F_{8, 132} = 0.813$, $p = 0.592$, $\eta^2 = 0.012$), however, a significant time effect was observed ($F_{3.08, 101.79} = 68.39$, $p < 0.001$, $\eta^2 = 0.597$). All groups experienced significant reductions in SQJ performance after the exercise ($p < 0.05$).

Correlation Analysis

The results indicated a strong correlation between muscle pain and muscle function ($p < 0.05$). Table 3 presents the correlation values between VAS and muscle function.

Discussion

This study investigated the effects of house cricket supplementation on muscle pain and force-generating capacity (maximum strength: isokinetic and isometric strength; and explosive contraction: jump height) following an eccentric exercise-induced pain protocol, and compared its effectiveness to whey supplementation. As anticipated, the exercise-induced pain protocol resulted in elevated pain scores (VAS) and reduced quadriceps muscle force-generating capacity. Despite persistent pain, house cricket supplementation accelerated recovery of maximum strength, showing comparable results to the whey-treated group. However, no differences in jump height were observed between groups. To our knowledge, this is the first study to demonstrate the post-exercise benefits of house cricket supplementation. It appears that house cricket supplementation can accelerate muscle function recovery, with the extent of recovery depending on the nature of muscle contraction—maximum force versus explosive contraction.

Immediately after the exercise, there was a significant increase in muscle pain (VAS score), peaking at 24 h and persisting up to 72 h post-exercise. This pattern aligns with previous studies using similar exercise-induced pain protocols (Clifford et al., 2016; Hilkens et al., 2021; Howatson et al., 2012; Miyama and Nosaka, 2004). Repeated eccentric contractions are well-known to cause muscle fibre damage (Cheung et al., 2003; Proske and Morgan, 2001), particularly in fast-twitch fibres (Macaluso et al., 2012), which triggers an inflammatory response and sensitises nociceptors, leading to increased pain sensation (Peake et al., 2017). In this study, all groups displayed similar VAS score patterns despite supplementation, consistent with other studies showing that high-protein supplements do not improve VAS ratings (Buckley et al., 2010; Cockburn et al., 2012; Cockburn et al., 2008). However, a few studies, including Abbott et al. (2019), Draganidis et al. (2017), and Hirose et al. (2013), reported reduced pain scores following protein-rich supplementation. These findings may be influenced by the crossover study design used, which, as noted by Pearson et al. (2023), is susceptible to confounding by the repeated-bout effect. This effect, which blunts the pain response after the initial exercise-induced damage (Miyama and Nosaka, 2004), can persist for 6 to 9 months, often resulting in insufficient washout periods (Howatson et al., 2012). As such, the results from these crossover studies must be interpreted with caution. Overall, the evidence suggests that protein-rich supplements do not alter the inflammatory response (Buckley et al., 2010; Cockburn et al., 2012; Hilkens et al., 2021) and are therefore unlikely to hasten pain recovery from exercise-induced pain.

Pain experienced following exercise can compromise muscle function (Hedayatpour et al., 2012). This phenomenon was evident in the present study, where VAS scores were strongly correlated with reductions in muscle function. Increased pain perception was associated with a corresponding reduction in force-generating capacity. Specifically, peak torque for KEX, KFX, and IKE was reduced by approximately 16, 6, and 20%, respectively. Similarly, jump heights in both the CMJ and the SQJ were negatively affected, with reductions of around 14%. It is plausible that the pain, which persisted for up to 72 h, triggered muscle inhibition as a protective mechanism to prevent further damage, thereby reducing force production (Vila-Chã et al., 2012).

Despite the pain experienced, both house cricket and whey supplementation promoted faster recovery of maximum strength beginning

24 h post-exercise. Similar findings have been reported in studies examining protein-rich supplements (Buckley et al., 2010; Cockburn et al., 2008; Cooke et al., 2010). This recovery is likely attributed to the high protein and essential amino acid content in the supplements, which increases blood amino acid levels and subsequently stimulates anabolic responses through mTORC1 signalling, a protein complex associated with muscle protein synthesis (MPS) (Lanng et al., 2023). Activation of this pathway is thought to accelerate muscle repair and facilitate the restoration of maximum strength (Pavis et al., 2021; West et al., 2017).

On the other hand, the supplements showed no benefits in aiding the recovery of jumping ability. This finding aligns with a study by Howatson et al. (2012), using similar drop jumps, which also reported no improvement in CMJ performance despite significant recovery in muscle strength after supplementation with branch-chain amino acids. It is postulated that the drop jump exercise, which is inherently explosive, impacts muscle fibre types (type I and II) and muscle recruitment patterns differently (Macaluso et al., 2012). Specifically, type-II muscle fibres are believed to be most affected by the eccentric nature of the drop jump protocol (Macaluso et al., 2012), potentially explaining the lack of recovery in subsequent jumping trials. Additionally, exercise-induced protective mechanisms may contribute to this outcome, including: (i) an altered recruitment pattern, characterised by decreased agonist and increased antagonist muscle activation (Vila-Chã et al., 2012), (ii) compromised proprioceptive function (Hedayatpour et al., 2012), and (iii) reduced neural drive (Racinais et al., 2007), all of which can impair an explosive jump performance. These factors suggest that the recovery rate varied depending on the nature of the motor task (maximum voluntary or explosive contraction) and the associated muscle activation alterations (Vila-Chã et al., 2012). Thus, it could be inferred that protein-rich supplements, including house cricket supplementation, may not expedite the recovery of explosive jump performance, due to persistent pain following eccentric exercise. In contrast, recovery of maximum voluntary contraction exhibited significant improvement, suggesting that the efficacy of house cricket supplementation varies depending on the type of the motor task.

Several limitations in this study must be acknowledged. First, the inclusion of recreationally active males limits the generalisability of the findings to other populations, such as females or well-trained athletes. In addition, concerns have been raised regarding the digestible protein value of house crickets and insects in general due to the presence of chitin (Jonas-Levi and Martinez, 2017). This may lead to a potential overestimation of their protein content. Future research should aim to clarify the nutritional profile of house crickets for use in related intervention studies. Furthermore, studies should investigate whether house cricket supplementation has a comparable effect on muscle recovery in other populations.

The increasing global demand for protein underscores the need to identify alternative protein sources. As exercise often necessitates greater protein intake (Paoli et al., 2024), this study highlights the potential benefits of insect consumption to meet such requirements. Insects are highly sustainable and boast a rich protein content (Brogan et al., 2021; Smetana et al., 2016), making them an appealing supplement option. In addition, their high fibre content may enhance gut microbiota and reduce inflammation (Stull et al., 2021), offering added benefit for gut health. While insect-based supplements are currently met with scepticism, raising awareness of their advantages could improve their acceptance (Placentino et al., 2021). It will be intriguing to observe whether insects emerge as a mainstream option for exercise supplements in the future.

Conclusions

Following a bout of eccentric drop jump exercise, participants experienced an increase in pain perception accompanied by reductions in maximum strength, including isokinetic and isometric knee extension, as well as explosive contraction performance measured by countermovement and squat jumps. Neither house cricket nor whey supplementation alleviated exercise-induced pain during the 72-hour experimental period. Interestingly, despite the persistent pain, house cricket supplementation accelerated the recovery of isokinetic and isometric knee extension strength, demonstrating effects comparable to whey protein. However, this recovery pattern was not observed in explosive contraction performance. This discrepancy may be attributed to the distinct nature of contractions and differing recovery rates between maximum voluntary and explosive contractions. These findings highlight the potential of house crickets as a sustainable protein source to support post-exercise muscle recovery, addressing the growing demand for protein while promoting environmental sustainability.

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