RBFEx
ISSN Online: 2675-1372

Revista Brasileira de Fisiologia do Exercício

Original article

Capsaicin supplementation enhances the physical performance of kickboxing athletes

A suplementação de capsaicina promove aumento no desempenho físico de atletas de kickboxing

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ABSTRACT

Aim: The aim of the study was to investigate the acute effect of Capsaicin supplementation on the heart rate (HR), rate perception of effort (RPE), and performance of Kickboxing athletes undergoing the Specific Kickboxing Circuit Training Protocol (SKCTP). Methods: The sample consisted of six black belt Kickboxing athletes (age 30.8 ± 6.47 years; height 1.76 ± 0.08 meters; body mass 82.43 ± 28.03 kg; experience in the sport 13.71 ± 9.21 years). A randomized, cross-over, double-blind design was implemented in two separate sessions, one week apart. One session involved 12 mg of Capsaicin supplementation (CAP), and the other involved Placebo supplementation (PLA). Results: The Wilcoxon test revealed that the total number of strikes thrown was significantly higher (p = 0.03; d = 1.55) in the Capsaicin condition (369.14 ± 12.10) compared to the Placebo condition (332.28 ± 31.23). The Friedman test demonstrated that the first round in the CAP condition was superior to the three rounds in the PLA condition, and the second round in CAP was superior to the second and third rounds in PLA. No differences were observed in the HR mean between the conditions (CAP = 132.42 ± 19.03 bpm and PLA: 133.57 ± 21.25 bpm; p = 0.87; d = 0.05) and in the RPE (CAP = 7.57 ± 1.51 and PLA = 7.00 ± 1.82; p = 0.43; d = 0.34). Conclusion: In conclusion, acute Capsaicin supplementation improved the performance of athletes in the SKCTP compared to the Placebo but did not show statistically significant differences in heart rate and Subjective Perceived Exertion.

Keywords: sports nutritional science; dietary supplements; martial arts.

RESUMO

Objetivo: O objetivo deste estudo foi investigar os efeitos agudos da suplementação de Capsaicina no desempenho físico de Kickboxers no Specific Kickboxing Circuit Training Protocol (SKCTP), na frequência cardíaca (FC) e na percepção subjetiva do esforço (PSE). **Métodos:** A amostra foi composta por seis atletas faixas pretas de Kickboxing (idade 30,8 ± 6,47 anos; altura 1,76 ¬± 0,08 metros; massa corporal 82,43 ± 28,03 kg; experiência na modalidade de 13,71 ± 9,21 anos). O delineamento randomizado, cruzado e duplo cego, foi aplicado em dois encontros separados por uma semana entre eles. Um para a suplementação de Capsaicina 12 mg (CAP) outro para a suplementação Placebo (PLA). **Resultados:** O teste Wilcoxon verificou que a quantidade total de golpes desferidos foi significativamente maior (p = 0,03; d = 1,55) na condição CAP (369,14 ± 12,10) em comparação à condição PLA (332,28 ± 31,23). O teste Friedman demonstrou que o primeiro round da condição CAP foi superior aos três rounds PLA, e que o segundo round CAP foi superior ao segundo e terceiro round PLA. Não foram verificadas diferenças na frequência cardíaca média entre as condições (CAP: 132,42 ± 19,03 bpm e PLA: 133,57 ± 21,25 bpm; p = 0,87; d = 0,05) e na Percepção Subjetiva do Esforço (CAP: 7,57 ± 1,51 e PLA: 7,00 ± 1,82; p = 0,43; d = 0,34). **Conclusão:** Conclui-se que a suplementação aguda de Capsaicina melhorou o desempenho dos atletas no SKTCP em comparação ao Placebo, mas não apresentou diferenças para FC e PSE.

Palavras-chave: ciências da nutrição e do esporte; suplementos nutricionais; artes marciais.

Received: November 19, 2023; Accepted: January 18, 2024.

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Introduction

Kickboxing is a combat sport discipline in which competitors aim to overcome their opponent by scoring points through strikes or technical knockout, using hands, elbows, knees, shins, and feet [1]. This is an intermittent characteristic sport discipline, which can consist of 3 to 12 rounds lasting 2 to 4 minutes, with a rest period between 1 to 2 minutes between rounds [1]. Therefore, it is necessary for practitioners to develop physical abilities such as cardiorespiratory endurance, strength, power, and agility, in addition to refining technical and tactical elements [2,3].

Upon analyzing official competitions in the discipline, three distinct phases were identified during the match: a) high-intensity offensive and defensive actions; b) low-intensity actions, preparation, and observation; and c) referee pause [4]. Therefore, in order to analyze the time-motion performance based on the physical demands of the discipline, it was developed the Specific Kickboxing Circuit Training Protocol (SKCTP) [4]. Therefore, the SKCTP can be used as a training tool and/or a test for assessing the physical performance of Kickboxers, exposing them to an effort-rest ratio and technical execution similar to official matches [4].

Seeking better results in training and competitions, various nutritional ergogenic resources are used by practitioners in various sports modalities [5]. Among them, Capsaicin, a substance found in peppers, has been extensively investigated in the literature in various contexts [6]. The Capsaicin interacts with the transient receptor potential vanilloid 1 (TRPV1) receptor, located in the sarcoplasmic reticulum [6], which promotes greater release of calcium, consequently enhancing the interaction between actin and myosin filaments, leading to increased performance during physical exercise [6,7]. Furthermore, another explanation for the performance enhancement may be the potential analgesic effect of Capsaicin when interacting with TRPV1, which would increase the discomfort threshold and reduce the rate of perceived exertion (RPE) [6,8].

In the literature, it is reported that 12 mg of Capsaicin administered 45 minutes before exercise may result in performance improvement [6]. However, the results from various studies are still highly contradictory. Researchers observed that Capsaicin supplementation was able to enhance strength training performance [9,10], decrease sprint time [11], and improve running performance at different distances [12], as well as reduce session rate of perceived exertion (sRPE) in Crossfit [8]. In contrast to these findings, other studies observed that Capsaicin did not improve performance in strength training [13], Crossfit [14], exhaustion runs [15], and long-distance running [16].

Given the divergence in results presented in the literature evaluating Capsaicin supplementation in physical performance [9,10,12-14] and the potential benefits of using this supplement in combat sports, this study is necessary. Therefore, the objective of this study was to investigate the acute effects of Capsaicin supplementation on the physical performance of Kickboxers, measured by the total number of

strikes performed in the SKCTP, heart rate (HR), and RPE. Moreover, based on the available literature regarding the benefits of Capsaicin, it is expected that athletes will improve performance in SKCTP, reducing HR and RPE.

Methods

Ethical considerations

All procedures adopted and the purpose of the research were explained to the athletes, as well as the possible risks and benefits. The athletes read and signed the Informed Consent Form. This project complied with all the rules established by the National Health Council (Resolution 466/2012). The research in question was submitted and approved by the Ethics and Research Committee of the Federal University of Minas Gerais (number: 5.683.532).

Sample

Six black-belt Kickboxing athletes participated in the study (age: 30.8 ± 6.47 years; height: 1.76 ± 0.08 m; body mass: 82.43 ± 28.03 kg), competing at the regional and national levels, with a mean experience of 13.71 ± 9.21 years in the sport. Body mass and height were measured using a Líder P-180c scale with an attached stadiometer (maximum capacity of 180 kg and minimum of 2.1 kg; precision of 0.1 kg and 0.5 cm).

Athletes included in the study did not consume any pre-training nutritional supplements, thermogenic substances, spicy foods, ginger, coffee, teas, alcohol, narcotics, or any stimulating substances before training sessions. Exclusion criteria included athletes with injuries to the upper and lower limbs or any other medical conditions that could interfere with the tests.

Study design

Respecting the randomized, crossover, and double-blind design, carried out through the draw of even numbers for Placebo and odd numbers for Capsaicin, athletes performed two sessions of the SKCTP, with a one-week interval between them. The SKCTP consists of strike sequences of straight punch, cross punch, and thigh-level kick (Low kick) on a punching bag. Three rounds of 4 sets were performed, with a duration of 20 seconds of stimulus (all out) per 6 seconds of interval between sets and 60 seconds of rest between rounds [4]. Additionally, during the execution of the SKCTP, average heart rate (HR) was measured, and at the end, the rating of perceived exertion (RPE). Figure 1 below illustrates the techniques employed and the effort--rest relationship of the SKCTP.

Tests procedures

To tally the strikes performed in the SKCTP, athletes were filmed using an Apple smartphone, iPhone 7 model (128 GB), mounted on a tripod set in a vertical

position at a distance of 4 meters, so as not to interfere with the athletes' execution of the strikes. The videos were analyzed by the same evaluator, who was blinded to the experimental condition. The footage was watched a minimum of 2 times and up to 3 times if there was a difference in the strike count. For the execution of the SKCTP, athletes used their usual training equipment to strike against a 25 kg punching bag suspended 150 cm above the ground. To ensure that athletes started and finished the sequence of strikes respecting the pre-defined times of the protocol, a mobile application (Tabata Timer: Interval Timer, developer: Eugene Sharafan) was used, emitting a specific audible signal for each time interval.

The Heart rate was measured pre and post-SKCTP using the Polar H10 heart rate monitor (Polar H10, Polar Electro Brazil, Ltda). The rate of perceived exertion was collected immediately at the end of the SKCTP protocol using the (CR-10) scale, ranging from 0 (rest) to 10 (maximum effort) [17].

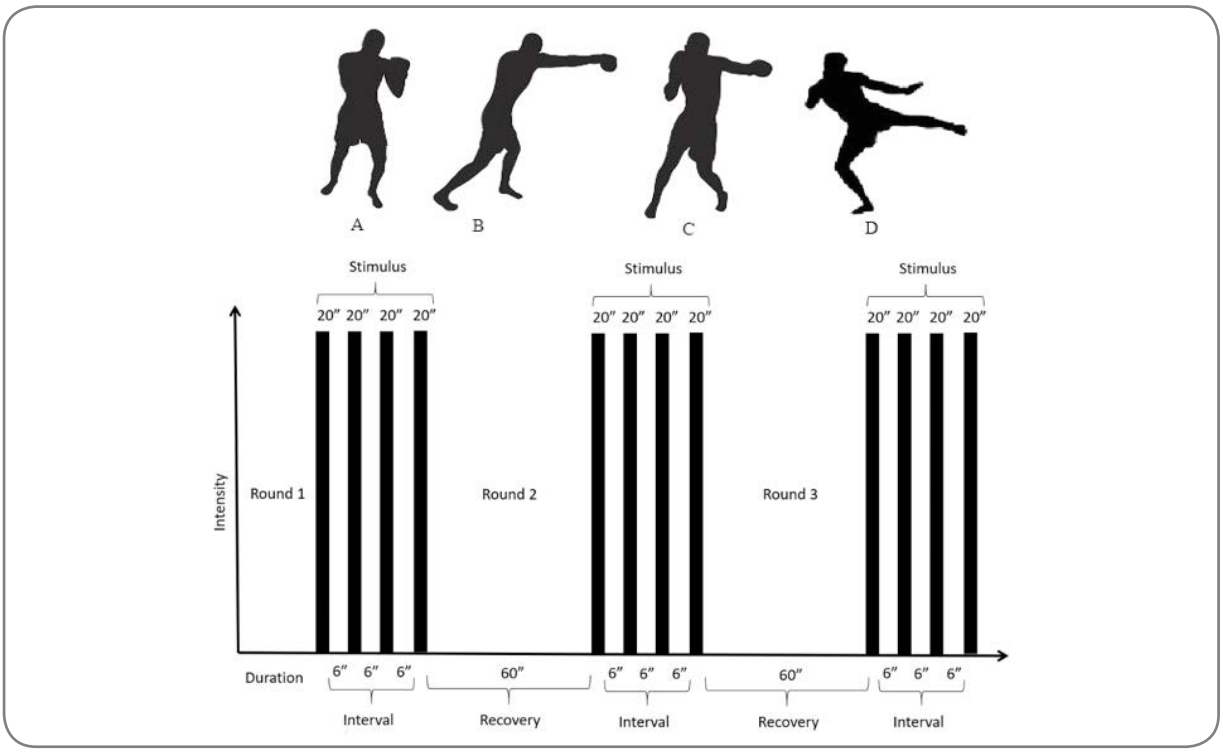
Capsaicin supplementation

During the testing sessions, through the random assignment of even numbers (Placebo) and odd numbers (Capsaicin), athletes consumed the substances in a random and blinded manner, in identical capsules obtained from a compounding pharmacy, following specifications provided by an experienced nutritionist. The Placebo capsule contained 50 mg of starch, while the Capsaicin capsule contained 12 mg. This Capsaicin dosage was chosen due to its effectiveness in improving physical performance [9-12], with no reported occurrences of side effects [13].

After supplement ingestion, a 45-minute interval was observed between capsule intake and the start of the testing protocol. This was done to ensure that the tests began at the peak concentration moment of Capsaicin following supplementation [6,9].

Statistical analysis

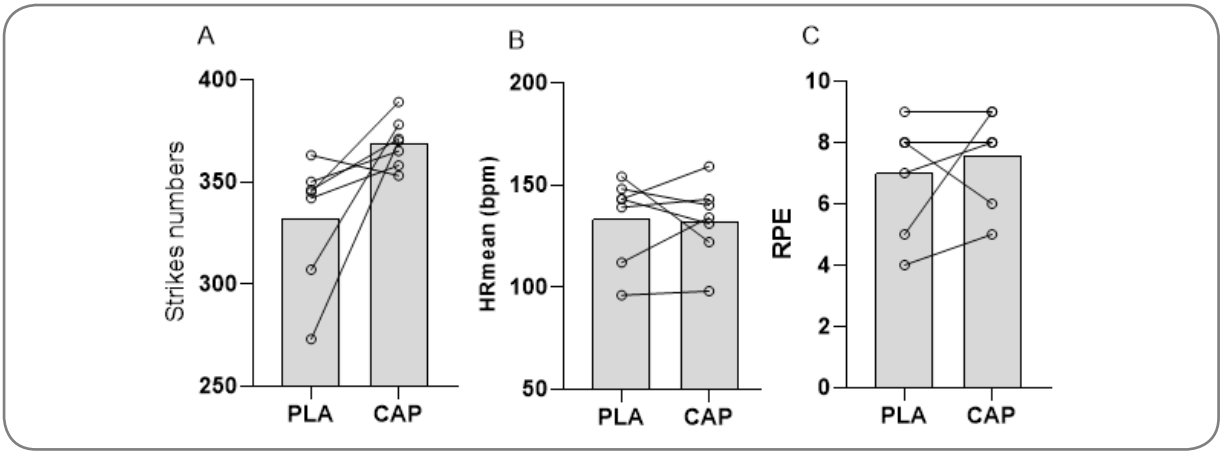
The data normality was assessed using the Shapiro-Wilk test. To compare the total number of strikes performed in the SKCTP, HR, and RPE between the Capsaicin and Placebo conditions, the Wilcoxon test was applied. The Friedman test was used to compare the number of strikes performed in each round. Cohen's d was employed to assess the effect size (small = 0.2 - 0.3; medium = 0.5 - 0.8; large > 0.8). The significance level adopted was $\alpha = 0.05$. Statistical analysis was conducted using the SPSS software (version 20.0).



A = Start; B = Direct Punch; C = Cross Punch; D = Low Kick.
Figure 1 - Strikes sequence and effort-rest ratio in SKTCP

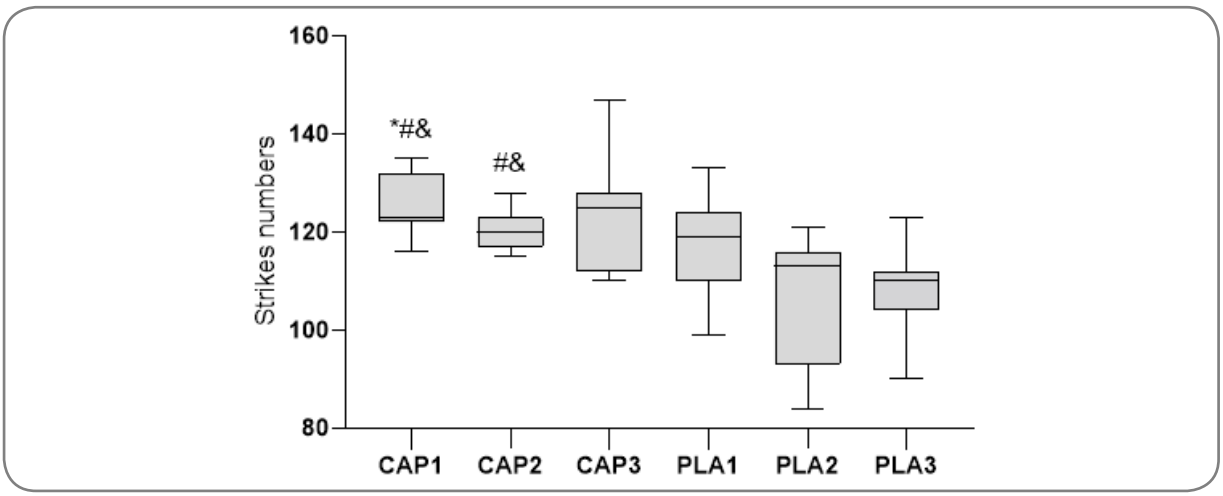
Results

The total number of strikes was significantly higher (t = 2.65, p = 0.03, d = 1.55) in the Capsaicin condition (369.14 ± 12.10) compared to the Placebo condition (332.28 ± 31.23). The mean HR showed no statistically significant difference (t = -0.16, p = 0.87, d = 0.05) in the Capsaicin condition (132.42 ± 19.03 bpm) when compared to the Placebo condition (133.57 ± 21.25 bpm). The RPE did not exhibit a statistically significant difference (t = 0.83, p = 0.43, d = 0.34) in the Capsaicin condition (7.57 ± 1.51) compared to the Placebo condition (7.00 ± 1.82). Figure 2 presents the values of the total number of strikes delivered, HR, and RPE in the Capsaicin and Placebo conditions.



PLA: =Placebo; CAP = Capsaicina. *statistical significance p ≤ 0,05
Figure 2 - A = strikes numbers in Specific Kickboxing Circuit Training Protocol. B = heart rate mean; C: rate of perceived exertion

The number of strikes per round was significantly higher in the first CAP round (125.71 ± 6.58) when compared to the first (117.57 ± 10.95, p = 0.02, d = 0.90), second (106.86 ± 13.46, p = 0.01, d = 1.77), and third PLA round (107.86 ± 10.02, p = 0.01, d = 2.10). The second CAP round (120.43 ± 4.24) was not significantly different from the first PLA round (p = 0.60, d = 0.34). However, it was significantly higher than the second (p = 0.04, d = 1.35) and third PLA round (p = 0.02, d = 1.63). The third CAP round (123.00 ± 12.94) did not differ from the first (p = 1.00, d = 0.45), second (p = 0.14, d = 1.22), or third PLA round (p = 0.06, d = 1.30). Figure 3 below illustrates these results.



*Statistical significance compared to PLA1. # statistical significance compared to PLA2. & statistical significance compared to PLA3

Figure 3 - Strikes numbers in Specific Kickboxing Circuit Training Protocol on firts, second and third rounds CAP (CAP1, CAP2 e CAP3) e PLA (PLA1, PLA2 e PLA3)

Discussion

The aim of the present study was to investigate the effect of Capsaicin supplementation on the physical performance of Kickboxing athletes. The formulated hypothesis was that Capsaicin would improve performance in the SKCTP, and that HR and RPE would be lower in the Capsaicin condition. The results found in this study show that the total number of strikes delivered was higher in the Capsaicin condition compared to the Placebo. However, there was no significant difference in HR and RPE.

To the extent of our knowledge, this was the first study that assessed the performance of Kickboxing athletes in a specific test of the modality using Capsaicin supplementation. We are not aware of other studies that evaluated Capsaicin supplementation in specific tests in other combat sports, which limits our discussion.

In the study by Freitas et al. [9], an increase in the total load (number of repetitions x mass) was observed in a protocol of 4 sets of repetitions to muscular failure, with an intensity of 70% 1RM, a 90-second rest, in the squat exercise when supplemented with Capsaicin. Results from other studies indicate that a dosage of 12 mg of Capsaicin was able to reduce the time in 1500-meter sprints in physically active adults [11] and time to exhaustion by 13% in a high-intensity interval training

protocol [10]. Supporting these findings, Costa et al. [12] report that acute Capsaicin supplementation also significantly improved performance in the 400 meters and 3000 meters time trial in trained individuals.

In the present study, Capsaicin supplementation increased the strikes within the same time frame in a specific test of the sport. This increase occurred with greater magnitude in the first round of the CAP condition compared to the three rounds of the PLA situation, and in the second round of the CAP condition compared to the second and third rounds of the PLA condition. Therefore, it is expected that in a match, Capsaicin supplementation could increase the probability of victory by points and/or knockout for the athlete who imposes a higher number of strikes. However, studies evaluating this hypothesis need to be conducted.

A possible explanation for the previously reported results is that Capsaicin may increase the activation of the TRPV1 receptor in skeletal muscle and enhance calcium release from the sarcoplasmic reticulum, influencing greater force production [18]. Additionally, another acute ergogenic effect of Capsaicin is its ability to stimulate substrate oxidation, increase lipolysis, and spare more muscle glycogen [19,20], which would reduce fatigue in long-duration and/or high-intensity activities where muscle glycogen is crucial for performance.

The muscle glycogen-sparing effect promoted by Capsaicin can contribute to Kickboxers, considering the effort-rest ratio, energy demands, and physical fitness that are crucial for success in the sport [2]. However, Opheim and Rankin [21] did not observe difference in the performance of athletes subjected to 15 sets of 30-meter sprints with 30 seconds of rest in the condition of 25.8 mg of Capsaicin for 7 days. The difference between the results of the study by Opheim and Rankin [21] and the present study may be due to the chosen training protocol and the administered dosage. Gastrointestinal discomfort was reported in the study by Opheim and Rankin [21], which may have affected the results.

Freitas et al. [9] and Freitas et al. [11] also assessed the effects of Capsaicin supplementation on the RPE, which was measured immediately after each set in strength training and at the end of the 1500m run, respectively. These authors found improvement in performance and lower RPE values in the Capsaicin condition compared to the Placebo condition. Additionally, Piconi et al. [8] also observed a decrease in session RPE after a Crossfit training protocol. The authors attribute the lower RPE values to the potential analgesic effect of Capsaicin [6], which could increase the discomfort threshold. However, the present study did not find a decrease in RPE in Kickboxers undergoing a specific test when supplemented with Capsaicin. Consistent with the findings of the present study, Piconi et al. [14] showed no significant difference in session RPE among female Crossfit competitors between the Capsaicin and Placebo conditions. The differences between the results of these studies may be justified by the characteristics of the sports demand and possibly by the motivational aspect in the execution of the task among athletes and practitioners of different modalities when performing general exercises and specific tests. However,

motivational aspects were not assessed in these studies, presenting a limitation for discussing these results.

The findings of these studies [9,11,13,14] suggest that the type of exercise is an important factor regarding the benefits of Capsaicin supplementation. It appears that this substance may have an ergogenic role according to the duration of the exercise, benefiting exercises that rely heavily on glycolysis [6,12], as is the case with Kickboxing [2,3,4,22].

It is important to note that this study has some limitations, such as a small sample size, the absence of general tests that assess other physical demands inherent to the modality, the application of a side effects questionnaire, and the measurement of lactate concentration to better characterize the energy demand in the test.

Conclusion

Acute Capsaicin supplementation increased the total number of strikes executed by Kickboxing athletes in a specific modality test. However, there were no statistically significant differences in heart rate and rate of perceived exertion between the supplemented conditions.

Conflict of Interest
The authors declare no conflict of interest.

Financing
This study is self-funded.

Authors' contribution
Conception and study design: Cruz VM, Gonçalves ME, Drummond MDM, and Silva RAD; **Data acquisition:** Cruz VM, Gonçalves ME, Nogueira RH, Mendes MD, Silva RAD; **Data analysis and interpretation:** Cruz VM, Gonçalves ME, Nogueira RH, Mendes MD, and Silva RAD; **Statistical analysis:** Cruz VM, Nogueira RH, Mendes MD, and Silva RAD; **Manuscript writing:** Cruz VM, Gonçalves ME, Silva RAD; **Critical manuscript revision for important intellectual content:** Cruz VM, Drummond MDM, and Silva RAD.

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