EFEITOS DA SUPLEMENTAÇÃO AGUDA COM SUCO DE CAJUÍNA (*ANACARDIUM OCCIDENTALE L.*) SOBRE O DESEMPENHO DE 10 KM E NAS RESPOSTAS PERCEPTIVAS EM CORREDORES RECREATIVOS

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Resumo. Devido à cajuína ser um produto composto de frutose, um carboidrato de maior absorção e um fruto natural, o presente estudo objetivou verificar se a suplementação de cajuína influenciaria a percepção subjetiva do esforço (PSE), prazer, excitação, fadiga mental (FM), motivação e humor durante um contrarrelógio de 10 km (TT10km) em corredores. Nove corredores do sexo masculino (32 ± 9,2 anos de idade; altura 171 ± 0,06 cm; massa corporal 70,94 ± 8,09 kg) completaram dois contrarrelógios de 10 km ingerindo 550 ml de bebidas contendo cajuína ou placebo. Durante o exercício, a PSE, a excitação e o prazer/desprazer foram registrados usando várias escalas categóricas. Antes e depois da TT10km, o humor (vigor e fadiga), a fadiga mental subjetiva (FM) e a motivação foram registradas. Além disso, a glicemia dos atletas foi avaliada antes da ingestão da suplementação e após o exercício. Os corredores apresentaram maior percepção de esforço durante o exercício na condição de cajuína ($p = 0{,}030$). Em ambos os tratamentos, houve efeito significativo apenas no tempo para PSE ($p = 0{,}006$, $\eta^2 = 0{,}549$) e prazer ($p = 0{,}030$, $\eta^2 = 0{,}446$), mas nenhum efeito sobre a excitação foi observado. Os resultados não mostraram diferença significativa entre os tratamentos para as variáveis FM, motivação, vigor e fadiga. Os resultados também não foram diferentes para a glicose nos tempos e tratamentos. Por fim, o presente estudo não apresentou efeitos positivos sobre TT10km após suplementação com cajuína. Em conclusão, a suplementação aguda de cajuína não parece afetar as variáveis perceptivas e o desempenho corredores recreativos submetidos a um contrarrelógio de 10km.

Palavras-chave: respostas psicológicas; cajuína; exercício físico; suco natural.

EFFECTS OF ACUTE CAJUÍNA (ANACARDIUM OCCIDENTALE L.) JUICE SUPPLEMENTATION ON 10-KM PERFORMANCE AND PERCEPTUAL RESPONSES IN RECREATIONAL RUNNERS

Abstract. Due to cajuína being a product composed of fructose, a carbohydrate of greater absorption and a natural fruit, the present study aimed verify whether the cajuína supplementation would influence the rating of perceived exertion (RPE), pleasure, arousal, mental fatigue (FM), motivation, and mood during a 10-km time trial (TT10km) in runners. Nine male runners (32 ± 9.2 years old; height 171 ± 0.06 cm; body mass 70.94 ± 8.09 kg) completed two 10-km time trials ingesting 550 ml of beverages containing cajuína or placebo. During exercise, RPE, arousal, and pleasure/displeasure were recorded using various categorical scales. Before and after the TT10km, mood (vigor and fatigue), subjective mental fatigue (MF), and motivation were recorded. In addition, athletes' blood glucose was evaluated before supplementation intake and after exercise. Runners showed higher perceived exertion during exercise in the cajuína condition ($p = 0{,}030$). In both treatments, there was a significant effect only on time for RPE ($p = 0{,}006$, $\eta^2 = 0{,}549$) and pleasure ($p = 0{,}030$, $\eta^2 = 0{,}446$), but no effect on arousal was observed. The results showed no significant difference between treatments for the variables MF, motivation, vigor, and fatigue. The results were also not different for glucose at the times and treatments. Finally, the present study did not show positive effects on TT10km after cajuína supplementation. In conclusion, acute cajuína supplementation does not seem to affect perceptual variables and performance of recreational runners undergoing a 10-km time trial. In conclusion, acute cajuína supplementation does not seem to affect perceptual variables and performance of recreational runners undergoing a 10-km time trial.

Keywords: psychological responses; cajuína; physical exercise; natural juice.

1 INTRODUCTION

The ergogenic effect of carbohydrate (CHO) ingestion or mouth rinse during endurance exercise, with different solutions (i.e., 7.5 and 15%), has been investigated in physiological and mainly perceptual aspects (Alexander, 2017; Martínez-Olcina *et al*., 2022). These perceptual responses are generally used to verify "what"the person feels when supplementing with CHO. For example, the Rating of Perceived Exertion (RPE) has been commonly studied (Alexander, 2017; Duckworth; Backhouse; Stevenson, 2013). The findings have shown that CHO intake (a drink containing 45g glucose or galactose) seems to attenuate RPE by increasing blood glucose levels and, thus, allow faster rates of CHO oxidation in prolonged physical exercise (Lavoie; Tremblay, 2020; Duckworth; Backhouse; Stevenson, 2013).

Studies have also investigated the effects of CHO intake on other perceptual variables (Alexander, 2017; Lavoie; Tremblay, 2020), such as arousal (Felt Arousal Scale - FAS) and pleasure/displeasure (Feeling Scale - FS). The FS assesses the pleasure and displeasure that individuals feel during physical exercise (Hardy; Rejeski, 1989), and FAS verifies the perceived level of arousal/activation of the subjects (Svebak; Murgatroyd, 1985) . Previous findings showed that CHO supplementation (solution of 6.4%) provided higher pleasure ratings during prolonged high-intensity intermittent exercise (Backhouse *et al*., 2007). In addition, Backhouse *et al*. (2007) reported that CHO intake increased the subjects' arousal.

The Profile of Mood States (POMS) is a mood assessment test commonly used in sports practice (Rohlfs *et al*., 2008). CHO supplementation also seems to provide mood changes by improving vigor and attenuation fatigue (Dupuy; Tremblay, 2019). These effects on mood are associated with prevention in the accumulation of serotonin (5-HT) (Winnick *et al*., 2005) and activation of brain areas (Ma *et al*., 2021; Lopes; Pereira; Silva, 2022).

Indeed, the use of sports supplements containing CHO is already well established in sports practice and has been studied due to its possible ergogenic effects on perceptive aspects during exercise and its practicality in consumption (Alexander, 2017; Martínez-Olcina *et al*., 2022). The primary form of carbohydrates typically ingested in exercise are glucose (polymers); however, intestinal glucose absorption can be limited by the intestinal glucose transport system (SGLT1 - sodium-dependent glucose transporter 1). On the other hand, intestinal fructose uptake is not regulated by the same transport system, as it largely depends on glucose transporter 5 (GLUT5) as opposed to SGLT1 transporters (Fuchs; Gonzalez; Loon, 2019). In this sense, knowing that fructose intake can further increase the total availability of exogenous carbohydrates (Fuchs; Gonzalez; Loon, 2019), it is important to investigate the ergogenic effects of natural juices containing CHO in their composition, specifically rich in fructose.

The last decades have been marked by the discovery natural products with ergogenic activity similar to sports supplements. In this sense, researchers in sport and exercise began to investigate the effects of natural products and juices, such as beet juice (Wightman *et al*., 2015), grape juice (Toscano, 2020), and cashew juice (Kaewbutra *et al*., 2016). Cashew (*Anacardium occidentale L.*) is a pseudo fruit native to Brazil that has been widely distributed in tropical countries (i.g. Thailand, Vietnam, and India) due to its application potential and high economic power in the industrial sector (Kaewbutra *et al*., 2016).

Cashew has been investigated for its composition of excellent properties such as vitamin C, organic acids, minerals, and CHO (Oliveira *et al*., 2020). In the context of physical exercise, studies suggest that long-term repeated supplementation with cashew juice positively affects physical performance (Kaewbutra *et al*., 2016; Prasertsri *et al*., 2013; Prasertsri *et al*., 2019). However, the acute effects of this juice have not yet been investigated.

The cajuína is a beverage obtained through clarified cashew juice with a good content of vitamin C, carotenoids, and phenolic compounds such as quercetin (Lima *et al*., 2007; Cavalcante *et al*., 2003). In addition, this product is also composed of CHO derived directly from the cashew apple (Lima *et al*., 2007). However, it is not yet known whether this product could have acute effects on physical performance.

Therefore, since cajuína has high rates of CHO in its composition (Lima *et al*., 2007; Cavalcante *et al*., 2003), we hypothesize that this product could improve performance and promote changes in RPE, subjective mental fatigue (MF), mood, pleasure, arousal, and motivation of athletes submitted to an endurance exercise. Thus, this study aimed to verify whether the cajuína supplementation would influence the perceived effort, pleasure, arousal, MF, motivation, and mood during a 10-km time trial (TT10km) in runners.

2 MATERIALS AND METHODS

2.1 Participants

The sample size was estimated using GPower 3.1 for the two-way ANOVA (i.e., two experimental conditions and three measurements) with a set power of 0.95, $\alpha = 0.05$, and an effect size of 0.81 (η^2) for RPE (Astorino *et al*., 2012). We used the perception of exertion as the main outcome variable to perform the sample calculation because it is the one that best explains endurance performance (Salam; Marcora; Hopker, 2018).

So, the results indicated that eight subjects would be necessary for the study. Participants were nine male recreational runners (age 32 ± 9.2 years; height 171 ± 0.06 cm; body mass (BM) 70.94 ± 8.09 kg). Previous studies (Alexander, 2017; Astorino *et al*., 2012) have adopted some participants similar to our study. The participants in this study had an average endurance training frequency of 3.9 (SD = 1.9) sessions/week, with a duration of 53 (SD = 16.9) minutes/session, and an average prior training experience of two years (with involvement in national and regional tournaments).

The subjects were considered moderately trained (level 2) according to their training status (Pauw *et al*., 2013). All participants reported not using any nutritional supplement for at least three months during this study. Subjects were non-smokers and free of medication and alcohol for at least three days before visits. Also, only the athletes with a 10-km performance time between 40-60 minutes (Castro, 2019); who were not regularly consuming cajuína or any by-product and rested 48 hours before the experimental visits. A local Ethics Committee approved our research protocol (protocol: #3.685.729) and performed it according to the Declaration of Helsinki. We explained our experimental procedures and the experimental risks and benefits to all participants, and we obtained their written informed consent to participate before collecting any data.

2.2 Experimental design and procedure

A double-blind, crossover, randomized, and placebo-controlled clinical trial was conducted and separated by a one-week washout interval. All the athletes performed two procedures, one experimental and another control, in a randomized crossover model (www.randomizer.org). Only one subject was excluded during the study due to a musculotendinous injury.

The participants visited the experimental facilities on three separate occasions. The first visit to the laboratory was used to explain all experimental procedures, scales, and TT10km (knowledge about the course). This type of test (TT10km) has been used in other studies evaluating CHO's effects on runners (Chen, 2008); Evans (2019). This distance seems to be a relatively reproducible method when measured in runners, which is important for research assessing the effect of diet on endurance running performance (Siu *et al*., 2004).

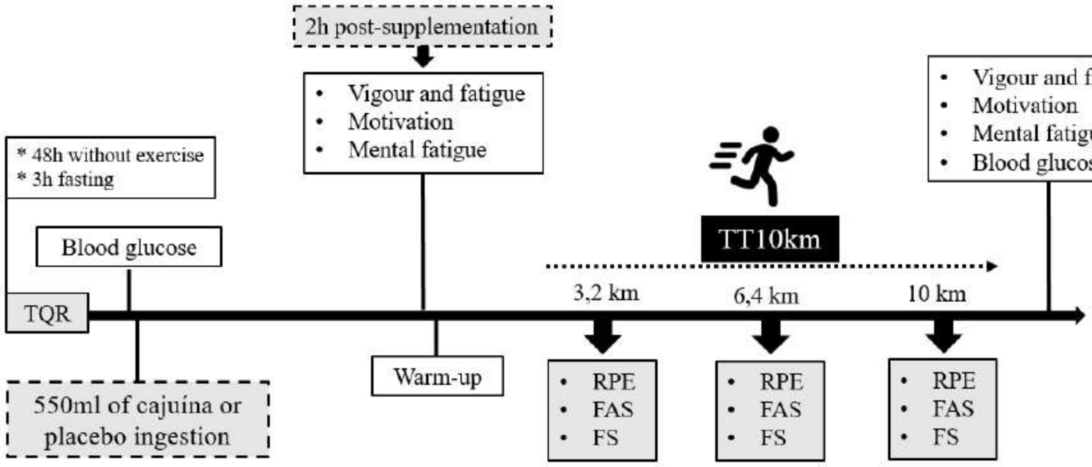
The athletes commonly performed a TT10km running in their training routines (i.e., they were already familiar) at the experiment site; that is, this allowed there to be no difference in the order of presentation because the athletes would already be familiar. Subsequently, two experimental visits with a one-week washout were used to allow the recovery of athletes (Toscano, 2020). After the last trial, participants were invited to identify any differences between the collections, procedures, and supplementations.

Figure 1 shows the procedures of experimental visits 2 and 3. After the arrival of the athletes in the laboratory, Total Quality Recovery (TQR) (Kenttä; Hassmén, 1998) was verified as a subjective pre-experiment measure. Subsequently, blood glucose was verified before the athletes ingested supplementation (cajuína or placebo). After two hours of ingestion (Vitale; Getzin, 2019)and before starting warm-up for the TT10km (Astorino *et al*., 2012), the mood subscales (vigor and fatigue) (Rohlfs *et al*., 2008), motivation (Salam; Marcora; Hopker, 2018), and the sensation of MF were evaluated (SALAM; MARCORA; HOPKER, 2018). During the TT10km, every 3.2 km (two miles), perceptual responses of RPE (Borg, 1982), pleasure/displeasure (Hardy; Rejeski, 1989), and arousal (Svebak; Murgatroyd, 1985) of the subjects were obtained.

[1]TQR = Total Quality Recovery; RPE = Rating of Perceived Exertion; FAS = Felt Arousal Scale; FS = Feeling Scale.

The experimental sessions (visits 1 and 2) were completed within two weeks. In all trials (i.e., TT10km), the subjects performed the exercise outdoors (Bertuzzi *et al*., 2014) and without the presence of opponents or another competitor (Castro, 2019), making the study more ecologically valid. It is noteworthy that all athletes performed the exercise always in the same course and place during the tests. Also, the TT10km was preceded by a self-determined warm-up and performed at the same time of the day; therefore, climatic conditions such as temperature

Figura 1: Delineation of the Experimental Sessions.



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(°C), wind (km/h), and humidity (percentage) were not controlled.

When we compare the data between cajuína and placebo treatments related to climatic conditions of temperature (29.89 ± 1.25 e 30.89 ± 1.02, respectively), humidity (62.44 ± 7.69 e 56.00 ± 6.59, respectively), and wind (13.05 ± 1.40 e 16.33 ± 1.57, respectively), no statistical difference was observed ($p > 0.05$). Also, it is noteworthy that these data regarding the time conditions (temperature, humidity, and wind) were used as covariates during the statistical analysis.

2.3 Supplementation protocol and characterization of cajuína juice and the placebo drink

The cajuína group used a commercially industrialized product (cajuína nordestina), which presents nutritional composition (100ml): 45 kcal; 11g carbohydrates (CHO); 0.8g proteins; 0g fat; 1.5g fibers; and 25mg sodium (Lima *et al.*, 2007). It is worth noting that the CHO present in cajuína is naturally derived from the cashew fruit (i.e., fructose). Review studies propose an intake of 30 to 60 grams of carbohydrate 1 to 4 hours before the competition/event with durations of less than 2.5 hours (Vitale; Getzin, 2019).

Thus, based on the recommended dietary guidelines for CHO intake and the amount of CHO present in cajuína (11g/100ml), the athletes ingested 550 ml of cajuína, that is, 60 g CHO derived from the product two hours before Tt10 km. Placebo solutions smelled corresponding (cashew juice) and contained 0% CHO and artificial sweeteners (aspartame), as proposed in another study (Alexander, 2017).

All drinks were administered double-blinded and were prepared by a separate drinks supervisor not directly involved in data collection. Drinks were served in an opaque sports drink bottle and were shaken vigorously before administering to subjects. Prior pilot work confirmed that the drinks were indistinguishable in taste and texture.

Also, the subjects did not know which product they were ingesting, so they believed they were consuming two different juice supplements. It is noteworthy that the product was financed by the researcher responsible; that is, no company involved in cajuína production financed this research. Therefore, there was no conflict of interest.

2.3.1 Monitoring of physical exercise status and dietary intake

Per previous studies (Astorino *et al.*, 2012; Toscano, 2020) and study control measures, runners were instructed to answer a 24-hour food record. This diet (i.e., amount of macronutrients, CHO, and total energy intake) was evaluated by the researchers and experts in the area, photocopied, and returned to the participants to follow the same diet the day before each trial. Before visits two and three, the subjects fasted for 3 hours of food and 2 hours of water ad libitum. The feeding before each trial was standardized between the participants and treatments, adopting a meal with low CHO. It is noteworthy that the athletes were instructed not to consume any other food after lunch. The runners also answered a record to monitor the current training and were asked to maintain the training volume during the study.

3 MEASURES

3.1 Rating of perceived exertion (RPE)

The RPE was obtained utilizing a Borg scale of 15 points Borg (1982). Participants were invited to report the RPE every 3.2 km and at the end of the TT10km. The instructions for the RPE scale were standardized according to the procedures described above to quantify and evaluate the conscious sensation of how hard, heavy, and strenuous was the TT10km.

3.2 Emotional arousal

The "Felt Arousal Scale" (FAS) is a scale used to measure emotional arousal (Svebak; Murgatroyd, 1985). This is a scale of six items ranging from 1 (low arousal) to 6 (high arousal). Thus, the subjects were invited to report how they felt every 3.2 km at the end of the exercise of each trial. These instructions were read to each participant: *"Estimate here how aroused you actually feel". By "arousal", we meant how "worked-up" you feel. You might experience high arousal in one of a variety of ways, for example, as excitement or anxiety, or anger. Low arousal might also be experienced by you in one of a number of different ways, for example as relaxation or boredom, or calmness.*

3.3 Pleasure/displeasure

The affect responses (pleasure/displeasure) were obtained using the 11-points feeling. This scale (Feeling Scale - FS) consists of a single-item bipolar scale (-5 to +5) uses descriptors as "neutral" (zero), "very good" (+5), and "very bad" (-5) to rate the affective valence. Before exercise, subjects were read the following text developed by (Hardy; Rejeski, 1989): During exercise, it is common to experience changes in mood. Some individuals find exercise pleasure, whereas others find it to be unpleasant. Additionally, feeling may fluctuate across time. That is, one might feel good and bad a number of times during exercise. Subjects were asked to report their pleasure/displeasure every 3.2 km (equating to every two miles) and immediately at the end of the exercise.

3.4 Mood

The mood was assessed before and after TT10km using the Brunel Mood Scale as described by (Rohlfs *et al*., 2008). The question used to assess participants' mood before and after exercise was, "How are you feeling right now?"(Azevedo *et al*., 2016). This procedure was adopted to avoid fluctuations in mood states, thereby increasing the predictive capabilities of the method (Marcora; Staino; Manning, 2009). BRUMS contains 24 items that can range from zero (nothing) to four (extremely) points each. Also, these scale items make up the six subscales: anger, confusion, depression, fatigue, tension, and vigor. However, similar to other studies that investigated the effects of some supplementations on mood (Alexander, 2017; Azevedo *et al*., 2016), the present study only considered the vigor scales (itens 2, 15, 20, and 23) and fatigue (items 4, 8, 10, and 21). The internal consistency (i.e., Cronbach alpha) among the volunteers on the vigor and fatigue scale was 0.79 and 0.82, respectively (Landis; Koch, 1977).

3.5 Subjective mental fatigue and motivation

As proposed by a previous study (Salam; Marcora; Hopker, 2018), the sensation of MF was evaluated by vas of two extremities anchored from 0 (none) to 100 (maximum). Runners were forced to respond, "How mentally tired do you feel now?"by making a horizontal mark on the 100mm scale. This instrument was applied before and immediately after TT10km by a single researcher in a laboratory. The ICC was 0.78 (CI 95% = 0.42 to 0.91) for VAS.

The motivation was evaluated through a visual analog scale of 100 mm with two opposing motivational descriptors, that is, 0 (zero) as "nothing motivated"and 100 as "extremely motivated"(Salam; Marcora; Hopker, 2018). Thus, the runners were forced to answer, "How motivated do you feel now?"by making a horizontal mark on the 100mm scale. This scale was also applied pre and post TT10km individually (i.e., only runners and researchers were in the laboratory). The ICC was 0.87 (CI 95% = 0.67 to 0.95) for the motivation scale.

3.6 Blood glucose and blood collection

3 mL of blood from the median vein was collected before the athletes ingested supplementation and immediately after exercise. Venous blood samples were collected in a laboratory and immediately separated and identified. Subsequently, blood glucose concentrations were determined employing the glucometer with venous blood and were inserted into the reactive strips of the glucometer (Accu-Chek Active Roche® Diagnóstica Brasil).

3.7 Statistical analysis

All data were presented as mean, standard deviation and analyzed using SPSS 26.0. Shapiro-Wilk and Levene tests evaluated normality and homogeneity of variances, respectively. The two-way ANOVA of repeated measures with Bonferroni post hoc test was used to examine condition interaction (Cajuína vs. placebo) x time (pre-TT10km) for vigor and blood glucose. The same test was used to analyze condition interaction (cajuína x placebo) x time (3.2 km x 6.4 km x 10 km) for pleasure/displeasure, RPE, and arousal.

The Greenhouse-Geisser correction was used to explain the assumption of sphericity of unequal variances between the groups. Once the MF, motivation, and fatigue presented non-normal distribution, the Generalized Estimated Equations (GEE) analyzed the interaction between condition (placebo x cajuína) and time (pre and post TT10km). The model of GEE was chosen based on the distribution (i.e., gamma), the goodness of fit (Quasi-likelihood under the Independence Model Criterion), and residual distribution.

As TT10km occurred outdoors, temporal conditions (temperature, humidity, and wind) were used as covariates for covariance analysis (ANCOVA) to compare exercise time between treatments (cajuína x placebo). It is worth noting that the homogeneity of the regression parameters was performed to verify the difference in the effect of covariates on the dependent variables of each treatment.

The effect size for the F ratio was expressed as a partial square (η^2). η^2 was interpreted as having no effect (0.000 to 0.003), small (0.010 to 0.039), moderate (0.060 to 0.110), large (0.140 to 0.200) (Cohen, 1988).

4 RESULTS

4.1 Rating of perceived exertion, felt arousal scale, and pleasure/displeasure

For RPE, the analysis of repeated measures (see Figure 3a) revealed no interaction effect (F2,16=0.391, p=0.683, η^2=0.047). However, there was a main effect of condition (F1,8=5,363; p=0.049, η^2=0.401), specifically in the distance 6.4 between treatments (p=0.030).

Also, a main effect of distance was observed (F2,16=9.733, p=0.006, η^2=0.549). The post hoc test showed an effect of the distance between 3.2 km and 10 km in the cajuína group (p=0.026) and between 6.4 km and 10km in the placebo condition (p=0.049).

For arousal scale (FAS) no main interaction effect (F2,16=1.474, p=0.055, η^2=0.259), condition (F1,8=5.048, p=0.055, η^2=0.387), and time (F2,16=0.743, p=0.491, η^2=0.085) were observed (see Figure 3b).

The data on FS showed no main interaction (F2,16=0.452, p=0.534, η^2=0.053) and condition (F1,8=0.021, p=0.888, η^2=0.003) effect; however, a major effect of time was observed (F1,8=6.437, p=0.030, η^2=0.446) (see Figure 3c)

4.2 Mental fatigue and motivation

Descriptive data analyses showed an increase in MF scores in both conditions (see Figure 4), but generalized estimation equation (GEE) analysis showed no significant pre- and post-exercise differences in placebo (β = 8.33 [CI 95%, -1.47 to 18.1; p = 0.09]) and cajuína (β = -8.00 [CI 95%, -20.9 to 4.96; p = 0.22]). Also, the analyses showed no differences between placebo and cajuína (β = -3.61 [CI95%, -11.1 to 3.90; p = 0.34]).

The pre- and post-exercise motivation scores in the placebo (β= -5.44 [CI 95%, -19.1 to 8.29; p = 0.43]) and cajuína (β = 4.55 [CI95%, -3.58 to 12.6; p = 0.27]) conditions did not differ significantly (see Figure 4). In addition, there were also no significant differences between treatments (β = 4.78 [CI95%, -3.08 to 12.6; p = 0.23]).

Figura 2: Figure 3A: Changes in the classification of perceived exertion during the trial time in response to cashew and placebo intake in runners; * is the main effect of distance. Figure 3B: Changes in arousal in response to cashew intake and placebo in runners during the trial time. Figure 3C: Changes in pleasure/displeasure during the trial time in response to cashew and placebo intake in runners. * is the main effect of distance.

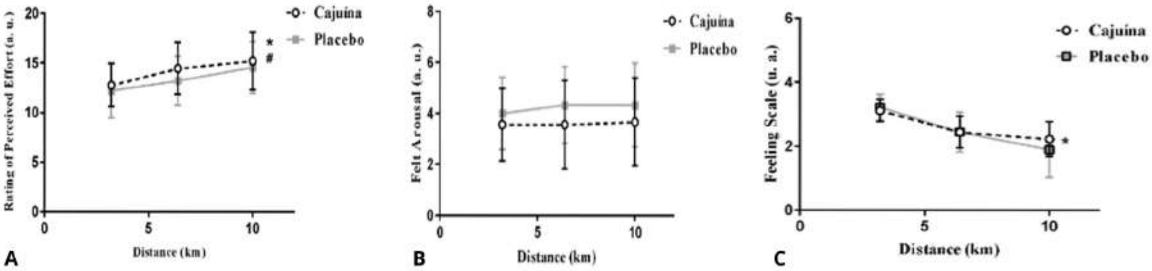

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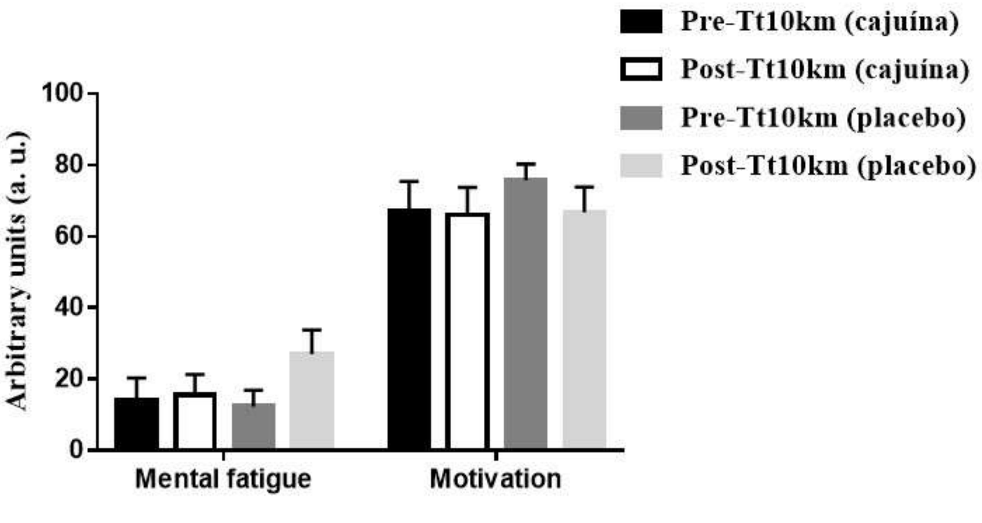
Figura 3: Mental fatigue and motivation in different experimental conditions.



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4.3 Mood (BRUMS)

For fatigue subscale (see table 1), no significant effect was found between treatments (β = -1.60 [CI95%, -3.96 to 0.76; p = 0.18]) and time under placebo (β = 1.92 [CI 95%, -1.28 to 5.12; p = 0.24]) and cajuína (β = 0.20 [CI95%, -3.28 to 3.69; p = 0.90]).

The analysis of repeated measures (see table 1) revealed no interaction (F1,8=0.327, p=0.583, η^2=0.039), condition (F1,8=0.028, p=0.871, η^2=0.004), and time (F1,8=4.665, p=0.063, η^2=0.368) effect for the vigor subscale.

4.4 Blood glucose

After a two way ANOVA of repeated measurements between the conditions pre cajuína supplementation (113.88 ± 5.24 mg/dL; CI95% = 101.79 to 125.98), pre placebo supplementation (111.33 ± 4.15 mg/dL; CI95% = 101.74 to 120.91), cajuína post exercise (113.88 ± 7.70 mg/dL; CI95% = 96.12 to 131.65), and placebo post exercise (111.66 ± 5.79 mg/dL; CI 95% = 98.31 to 125.01), the results revealed no major interaction effect (F1,8=0.002, p=0.962,

Tabela 1: Subscales of mood in different experimental conditions. Values are expressed as means ± standard deviation (CI).

Conditions	Fatigue	Vigor
Pre-TT$_{10km}$ (cajuína)	5.70 ± 0.90 (3.93 - 7.47)	9.77 ± 1.19 (7.01 - 12.54)
Post-TT$_{10km}$ (cajuína)	5.49 ± 1.44 (2.66 - 8.32)	8.00 ± 1.58 (4.35 - 11.64)
Pre-TT$_{10km}$ (placebo)	1.97 ± 0.55 (0.88 - 3.07)	10.22 ± 0.99 (7.92 - 12.52)
Post-TT$_{10km}$ (placebo)	3.89 ± 1.37 (1.20 - 6.58)	7.77 ± 1.35 (4.66 - 10.89)

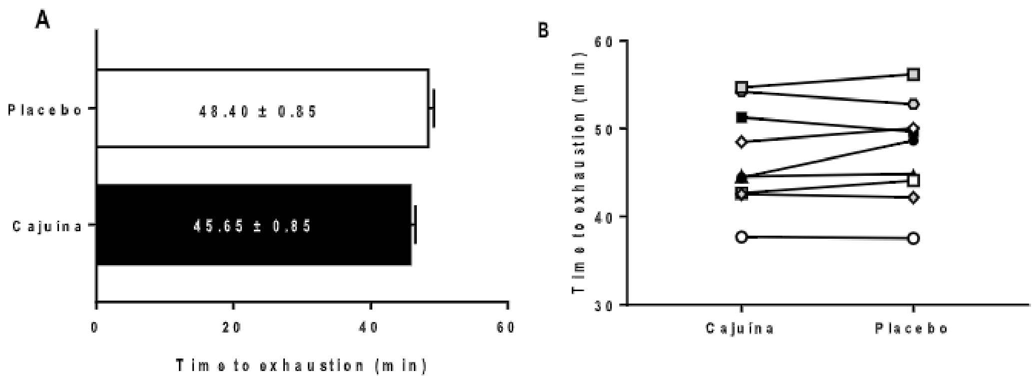
Source: Authors

η^2=0.000), condition (F1,8=1.059, p=0.333, η^2=0.117), and time (F1,8=0.000, p=0.984, η^2=0.000).

4.5 Performance

Although the cajuína group (CI95% = 43.67 to 47.63) showed a 5.68% reduction in time compared to the placebo group (CI95% = 46.41 to 50.37), data on covariance analysis showed no significant difference between treatments (F1,8=4.203, p=0.074, η^2=0.344) (see Figure 4A). Figure 4B shows that there was a variance among the athletes.

Figura 4: Effects of cajuína on run time (in minutes) on TT $_{10km}$. Values are presented as average ± SD. Figure 4B: Shows the individual results of each athlete's absolute running time in each treatment.



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5 DISCUSSION

This study aimed to analyze the effects of cajuína on mood and perceptive responses of male runners submitted to a simulated time trial of 10km. Unlike what was hypothesized, the findings showed no differences between the treatments cajuína and placebo for the variables of mood (subscales fatigue and vigor), MF, motivation, arousal, and pleasure. It was possible to notice that the performance presented a tendency to improve, but only five out of nine runners. However, the results indicated a higher RPE dur ng the exercise and improved performance in the cajuína condition.

Although there was no significant difference in the TT10km time in the present study, the results show a reduction of 5.68% in the assay that individuals ingested cajuína nut compared to placebo. Although cajuína presents high values of quercetin (Lima *et al.*, 2007), the acute effects of this product were not observed on the athletes' performance. Previous studies suggest that quercetin supplementation is performed repeatedly in the long term for better Endurance exercise performance, specifically in untrained subjects (Pelletier; Lacerte; Goulet, 2013). Therefore, since cajuína supplementation was performed with only one dose and in trained individuals, the effects of this product were not observed in runners during a TT10km.

Indeed, since cajuína also has high CHO rates in its composition (Lima *et al.*, 2007), it was expected that this product would have an ergogenic effect by providing muscle glycogen saving, maintenance of blood glucose levels, and increase in the oxidation rate of CHO (Coyle, 1986). However, it seems that these mechanisms of CHO intake do not apply to exercises lasting less than 60 minutes (Carter, 2003). In addition, other findings suggest that supplementation with CHO after overnight fasting promotes better performance effects than when subjects are fed (Alexander, 2017; Backhouse *et al*., 2007). In this sense, it is worth mentioning that the individuals in this study ate 5 hours before exercise and 3 hours before supplementing with cajuína; they were not deprived of muscle glycogen. It is also important to note the relevance of blood glucose values when discussing perceptive responses.

The data showed that RPE increased during exercise and differed between treatments during kilometer 6.4. Most of the findings in the literature reveal an increase in RPE during exercise (Alexander, 2017; Astorino *et al*., 2012; Backhouse *et al*., 2007), as found in the present study. However, with cajuína, the performance time was improved; in this context, it is suggested that this increase in RPE in the cajuína condition of the placebo group is associated with a higher workload during the time trial (Astorino *et al*., 2012).

In addition, we hoped that the Cajuína could reduce the RPE. Previous research has suggested that a glycoside solution, upon contact with the oral cavity, seems to stimulate receptors in the mouth that would be associated with areas of the brain involved with the dopaminergic release (e.g., ventral tegmental area), perceived effort during exercise (e.g., insula, orbitofrontal, and striated cortex) (Backhouse *et al*., 2007; Chambers; Bridge; Jones, 2009). However, it seems that glycoside solutions of CHO present immediate effects on the RPE; in this context, since the cajuína supplementation was administered two hours before the TT10km, the athletes did not reveal effects on the RPE.

Utter *et al*. (2009) hypothesized that supplementation with quercetin could mitigate the perception of effort during prolonged exercise. However, since cajuína presents quercetin in its composition (Lima *et al*., 2007; Cavalcante *et al*., 2003), we hoped that this product could reduce RPE during the exercise. In vitro studies show that quercetin is an antagonist of adenosine A1 receptors (Alexander, 2006). However, (Utter *et al*., 2009) explained that this flavonoid undergoes considerable chemical modification in humans during digestion and absorption. In this sense, this would explain why the acute supplementation with cajuína did not affect the RPE.

Our results revealed that the pleasure decreased significantly throughout the exercise. Indeed, the literature reports a dose-response relationship between exercise intensity and affective sensation (Ekkekakis; Parfitt; Petruzzello, 2011). Thus, in exercises such as the simulated time trial, in which the subjects perform in greater intensity, the pleasure is negatively affected along with the distance (Astorino *et al*., 2012). In addition, it was seen that the Cajuína supplementation did not alter the athletes' pleasure. Researchers propose that changes in pleasure during prolonged exercise (Endurance) would be associated with high blood glucose levels and reduction of plasma cortisol (Backhouse *et al*., 2007). However, it was seen that there was no difference in blood glucose levels between treatments.

The findings showed that the arousal did not change along with the distance, and there was no difference between the trials. (Backhouse *et al*., 2007) investigated the effect of CHO supplementation on trained men who underwent 120 minutes of exercise after a night of fasting. The results of this study (Backhouse *et al*., 2007) showed that arousal was higher in the last 30 minutes of exercise in the CHO trial, however, supplementation with CHO allowed plasma glucose concentrations to be maintained. It is worth noting that (Backhouse *et al*., 2007) supplemented the subjects immediately before and during exercise after a night of fasting. Thus, since the cajuína supplementation was performed two hours before exercise without a state of glycogen reduction, this would explain why the cajuína did not influence the subjects' arousal.

When we analyzed the values of MF, motivation, fatigue, and vigor, no beneficial effects of Cajuína were observed. Indeed, it seems that the ingestion of CHO would positively affect mood, specifically the maintenance of vigor and the reduction of fatigue from the pre-exercise condition to the post-exercise one (Winnick *et al*., 2005). The authors explain that CHO prevents the accumulation of serotonin (5-HT) in the brain; however, this effect appears when CHO is ingested immediately before exercise (Alexander, 2017). Although such explanations are only speculation, it is proposed that supplementation with cajuína immediately before the exercise would better affect mood.

Our study has some limitations. First, although the combined application of RPE, FS, FAS, BRUMS, motivation, and MF allows a broad assessment of perceptual measurements during a simulated TT10km, it is suggested that future studies increase the number of participants due to the sensitivity of these evaluations/measures. In addition, this is the first study to verify the effects of acute cajuína intake (*Anacardium occidentale L.*), meaning that direct comparisons with other studies are not possible. However, such results were found according to the proposed methodology; thus, it is essential to investigate the effects of Cajuína with other approaches (i.e., different exercises, controlled laboratory environments, administration of the cajuína chronically or immediately before and during the exercise).

6 CONCLUSION

This study provided an initial insight into the impact of cajuína supplementation on perceived sensations during exercise. We conclude that a single dose of cajuína two hours before exercise did not alter the pleasure, arousal, or other sensations perceived by participants during a simulated endurance exercise. Despite these results, it is crucial to recognize that this study is not definitive and suggests the need for more research.

We recommend that future studies consider additional variables, such as the time of prolonged consumption of cajuína and their impact on different population groups. In addition, we suggest that more detailed analyses be carried out on the cultural importance of cajuína and its relationship with the practice of physical exercise.

Although our study did not find significant evidence of the influence of cajuína on the sensations perceived during exercise, there is a need to continue investigating its potential and effects in different contexts. This work not only broadens our understanding of cajuína, but also underscores the importance of valuing and exploring natural and regional products in future research on physical exercise and health.

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