

A SUPLEMENTAÇÃO AGUDA DE CHOCOLATE PODE MELHORAR O TESTE DE DESEMPENHO EM CICLOERGÔMETRO?

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Resumo: Estudos têm demonstrado que a suplementação crônica de chocolate amargo promove melhorias nos parâmetros semelhantes aos observados após o exercício de *endurance*. Os potenciais efeitos da ingestão de chocolate amargo no desempenho do exercício aeróbico são controversos e há questionamentos a respeito da quantidade ideal de chocolate a ser consumido para melhorar a *performance*. Portanto, o objetivo foi verificar o efeito da suplementação aguda de 80 g de chocolate amargo (70% cacau) sobre o desempenho do teste em cicloergômetro. Participaram do estudo 11 homens saudáveis, fisicamente ativos, mas não treinados (27.8 ± 3.2 anos, 76.4 ± 10.1 kg, 177.5 ± 8.2 cm). Dois testes incrementais em cicloergômetro foram realizados para determinar a potência de pico (P_{pico}) sem suplementação de chocolate (condição controle, C) e com suplementação de 80 g de chocolate amargo 70% cacau (C70%) ingeridos duas horas antes do teste. Variáveis como frequência cardíaca (FC), concentração de glicose sanguínea (GLI), pressão arterial (PAS/PAD) e percepção subjetiva de esforço (PSE) foram monitoradas. A normalidade dos dados foi verificada pelo teste de Shapiro-Wilk, e os resultados estão apresentados como média $\pm$ desvio padrão (DP). Os dados de desempenho dos testes e as variáveis fisiológicas foram comparados pelo teste t de *Student* para amostras pareadas, adotando nível de significância de $P < 0.05$. Não foram encontradas diferenças estatísticas para P_{pico} ($238,0 \pm 35,1$ vs. $250,9 \pm 42,7$ W) entre as condições (C e C70%, respectivamente), bem como nas demais variáveis. Concluímos que, embora a ingestão de 80 g de chocolate amargo (70% cacau) 2 horas antes do teste de cicloergômetro não tenha modificado o pico de potência nas variáveis fisiológicas e psicofisiológicas analisadas na apresentação dos resultados, a análise individual demonstrou que essa suplementação poderia ser usada para aumentar a P_{pico} , que apoia a análise individual e não de grupo para avaliar as respostas de desempenho aos protocolos de suplementação.

Palavras-chave: Cacau; Polifenóis; Exercício; Performance Atlético.

Afiliação

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CAN DARK CHOCOLATE ACUTE SUPPLEMENTATION IMPROVE CYCLOERGOMETER PERFORMANCE TEST?

Abstract: Prevalence studies of dark chocolate may produce results similar to those observed after resistance exercise. The results examining the effects of dark chocolate ingestion on aerobic exercise performance are controversial. In addition, there is a choice in experiments with chronically consumed chocolate components (40 to 80 g) and large amounts of dark chocolate in studies to improve athletic performance. Therefore, the purpose of this study to verify the effect of acute supplementation of 80 g dark chocolate (70% cocoa) on performance on cycle ergometer test. Eleven healthy, physically active, but untrained men (27.8 ± 3.2 years old, 76.4 ± 10.1 kg, 177.5 ± 8.2 cm) participated in this study. Two incremental cycle ergometer tests were performed to determine the peak power output (P_{peak}) without chocolate supplementation (control condition, C) and with supplementation of 80 g of dark chocolate 70% cocoa (C70%) ingested orally two hours before the test. Variables such as heart rate (HR), blood glucose concentration [GLI], blood pressure (SBP/DBP), and rating of perceived exertion (RPE) were monitored. Data normality was verified by the Shapiro-Wilk test, and the results are presented as mean $\pm$ standard deviation (SD). The performance data of the tests and physiological variables were compared using Student's t-test for paired samples, adopting a significance level of $P < 0.05$. No statistical differences were found for P_{peak} (238.0 ± 35.1 vs 250.9 ± 42.7 W) between conditions (C and C70%, respectively), as well as in the other variables. Therefore, we concluded that although the ingestion of 80 g of dark chocolate (70% cocoa) 2 hours prior the cycle ergometer test did not modify the peak power output, physiological and psychophysiological variables analyzed when presenting the average results, individual analysis demonstrated that this supplementation could be used to enhance P_{peak} , which support individual as opposed to group analysis to evaluate performance responses to supplementation protocols.

Key words: Cocoa; Polyphenols; Exercise; Athletic Performance.

Introduction

The combination of physical exercise and nutritional substances, aimed at improving athletic performance, has increasingly aroused the interest of researchers. However, there is still much debate about the efficacy of most substances, including the polyphenols present in cocoa¹. These substances induce the release of nitric oxide (NO), which is known to promote vasodilation, prevent the formation of free radicals, lower blood pressure, and protect against oxidative stress and inflammation^{2,3}.

Studies have indicated that chronic supplementation of dark chocolate (two weeks to three months) promotes improvements in parameters similar to those observed after endurance exercise. However, few studies have investigated the effect of cocoa ingestion and dark chocolate in association with the practice of physical exercises^{4,5,6} a combination that could further optimize the performance, as chocolate also has energizing properties. Patel et al.⁵ observed an improvement in performance during a cycle ergometer test consisting of a 20-minute warm-up at submaximal intensity, followed by a two-minute time limit at maximal effort, after two week daily chronic consumption of dark chocolate (40 g) in moderately trained men. On the other hand, Allgrove et al.⁶ did not observe an improvement in endurance during a cycle ergometer test, which consisted of cycling for 1.5 hours at 60% of maximal oxygen uptake ($\dot{V}O_{2max}$) with sprints of 30 seconds each 10 min, followed by a 90% intensity of $\dot{V}O_{2max}$, after daily chronic consumption of dark chocolate (80 g, 70% cocoa) for two weeks.

Results examining the potential effects of dark chocolate intake on aerobic exercise performance are controversial. In addition, there is a difference in the experimental protocols amounts of chronically consumed chocolate (40 to 80 g), and ideal amounts of dark chocolate used in the studies aimed to improve athletic performance. Therefore, the objective of this study was to verify the effect of acute intake of 80 g bitter chocolate (70% cocoa) on performance in the cycle ergometer test. We hypothesized that the acute supplementation of 80 g of dark chocolate (70% cocoa), ingested prior to the incremental cycle ergometer tests, would promote changes in the physiological, psychophysiological variables and peak power (P_{peak}).

Methods

Experimental Approach to the Problem

In a crossover design, participants underwent two maximum incremental tests in

cycloergometer (Inbramed® CG-04) to determine the power output, the random sequence was separated by a 1-week washout period. In the one condition, participants did not consumed chocolate, since this condition was characterized as control (C), in the other one, participants consumed 80 g of dark chocolate with 70% cocoa (C70%) two hours before test.

Procedures

Determination of peak power output (P_{peak})

The cycle ergometer test protocol started with three-minute warm-up at 60 Watts (W) and the first stage was at 90 W with increments of 30 W every three minutes, maintaining a cadence of 70 ± 2 rotations per minute (rpm) until the individual volitional exhausting, when in the final stages of the test, experiencing signs such as hyperventilation, facial redness, and uneven strides, the participant voluntarily decided to cease the test.

Blood samples were collected at the start and end of the tests to determine glucose concentration. Rating of perceived exertion (RPE, Borg scale of 6-20 points) and Heart Rate (HR, Polar RS800®, Kempele, Helsinki) were checked at each turn and at the end of the test. In addition, the systolic blood pressure (SBP) and diastolic blood pressure (DBP) was checked before (SBP/DBP_{pre-}) and after (SBP/DBP_{post-}) the test.

The blood glucose concentration was analyzed at the pre- (GLI_{pre-}), post-test time (GLI_{post-}), after the incremental test at the third (GLI_{3-min}) and fifth minutes (GLI_{5-min}) from a blood sample of the index finger (0.6 µL) (OptiumXceed®, Abbot, Brazil) and the result are reported in milligrams per deciliter (mg·dL⁻¹).

Subjects

Eleven untrained and healthy men (27.8 ± 3.2 years old, 76.4 ± 10.1 kg, 177.5 ± 8.2 cm) without experience in race events or participants of any training systematized in this modality took place in this study. Written informed consent was obtained from all participants and the study was approved by the local Ethics Committee (#262.502/2015). To participate in the study, participants should not have chronic-acute disease, including any type of metabolic disease, abnormality, or major cardiovascular risk factor, or both, as well as use any type of medication or dietary supplement and have an intolerance to cocoa base. In addition, they could not be participating in any type of systematic training, be smokers and habitual consumers of equal or greater amounts of chocolate or other cocoa products that would be used in the present study.

Participants who did not adapt to the incremental test protocol and/or who were unable to consume the amount of chocolate established in the study were excluded from the study. Participants were advised to attend the well-hydrated test local, and the last meal done at least two hours prior to the start of the tests. They were also instructed to abstain from caffeinated or alcoholic beverages and strenuous physical exercise within 24 hours prior to testing and to consume the same diet and to maintain the same physical exercise regimen 48 hours prior to testing.

Statistical analysis

Data were analyzed by the Statistical Package for the Social Sciences (SPSS® version 20.0). Data normality was verified by the Shapiro-Wilk test and the results are presented as mean $\pm$ standard deviation (SD). The performance data of the tests and physiological variables were compared using Student's t-test for paired samples, adopting a significance level $P < 0.05$.

Results

The variables obtained during the maximal incremental test in cycloergometer to determine the P_{peak} are presented in table 1. No differences were found for all the variables between conditions ($P < 0.05$).

Table 1 - Comparison between the variables obtained in the cycle ergometer test: P_{peak} (W), HR_{max} (bpm), RPE_{max} (6-20, AU), and duration of the test (min) in the conditions C and C70% (N = 11).

Variables	C	C70%	P
P_{peak} (W)	238.0 $\pm$ 35.1	250.9 $\pm$ 42.7	0.07
HR_{max} (bpm)	174 $\pm$ 10.2	177 $\pm$ 7.8	0.30
RPE_{max} (6-20, AU)	18.9 $\pm$ 1.4	19.5 $\pm$ 0.8	0.11
Test duration (min)	20.7 $\pm$ 3.5	21.9 $\pm$ 4.3	0.07

W: Watts; P_{peak} : peak power; bpm: beats per minute; HR_{max} : maximum heart rate; RPE_{max} : maximum rating of perceived exertion; AU: arbitrary units; $P < 0.05$.

Display the results of the GLI_{pre-} , GLI_{post-} , GLI_{3-min} , and GLI_{5-min} ; SBP/DBP_{pre-} , and SBP/DBP_{post-} are presented in table 2. There were no significant differences for all the variables between conditions.

Table 2 - Values of GLI ($mg \cdot dL^{-1}$) and SBP/DBP (mmHg) obtained during the incremental test in the conditions C e C70% (N = 11).

Variables	C	C70%	P
GLI_{pre-} ($mg \cdot dL^{-1}$)	95.9 ± 16.3	97.4 ± 11.5	0.77
GLI_{post-} ($mg \cdot dL^{-1}$)	86.5 ± 11.9	92.7 ± 8.9	0.17
GLI_{3-min} ($mg \cdot dL^{-1}$)	83.0 ± 9.3	91.6 ± 11.1	0.10
GLI_{5-min} ($mg \cdot dL^{-1}$)	81.7 ± 8.7	87.5 ± 9.1	0.16
SBP/DBP_{pre-} (mmHg)	$126 \pm 10/65 \pm 9$	$119 \pm 14/63 \pm 6$	0.09
SBP/DBP_{post-} (mmHg)	$158 \pm 62/22 \pm 8$	$150 \pm 10/62 \pm 10$	0.26

GLI: Glycemia; SBP: systolic blood pressure; DBP: diastolic blood pressure; $P < 0.05$.

The individual results of the P_{peak} and test duration in the C and C70% conditions are presented in figure 1. Of the 11 participants who completed the study, nine presented a greater P_{peak} and test duration in the C70% than in the C condition.

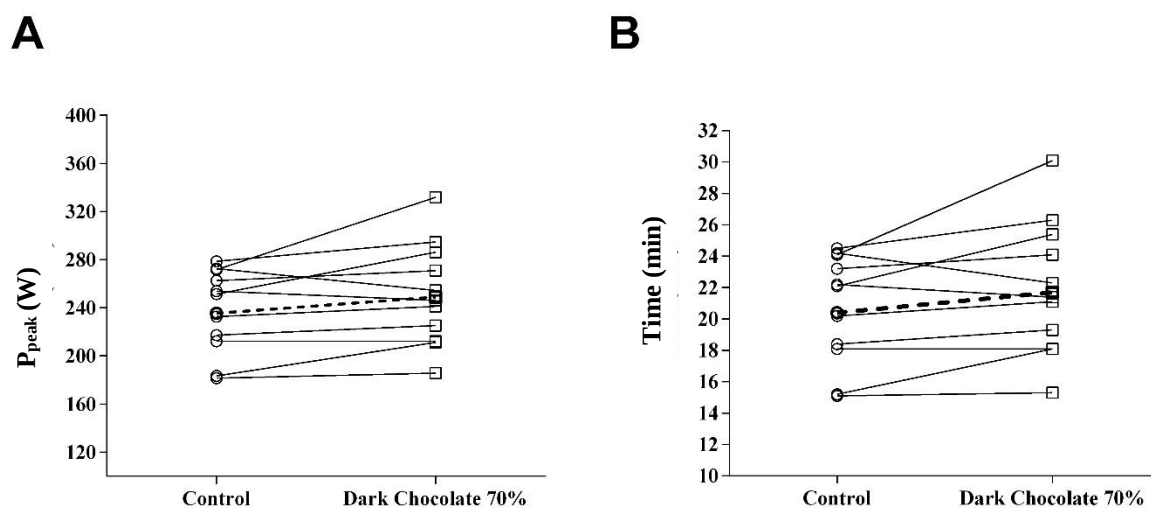


Figure 1- Individual results of the P_{peak} and test duration in the control (C) and dark chocolate 70% cocoa (C70%) conditions.

W: Watts; P_{peak} : peak power; min: minute; $P < 0.05$.

Discussion

The aim of this study was to verify the effect of acute intake of 80 g dark chocolate (70% cocoa) on performance in cycle ergometer test. The main finding was that the ingestion of 80 g of dark chocolate did not modify the peak power output in the cycle ergometer test or the maximum responses of HR, RPE, GLI and blood pressure. Therefore, our hypothesis was not confirmed.

The results of the present study regarding peak power output after dark chocolate ingestion in a cycle ergometer test were similar to those of the study by Allgrove et al.⁶, who did not observe an improvement in the endurance performance in the cycle ergometer test. However, the researchers only investigated the effect until exhaustion at 90% ($\dot{V}O_{2max}$), and the duration of the test may have been short to observe any improvement. On the other hand, Taub et al.⁴ observed a significant difference in P_{peak} after evaluating the effect of chronic ingestion of 20 g of dark chocolate per day during three months in 20 sedentary men. This improvement is related to the potential effects of dark chocolate intake, that is, the increase in vasodilation and consequent improvement of $\dot{V}O_{2max}$ and oxygen consumption at submaximal intensities⁵. These same modifications were also observed after intervention of endurance training.

Although the present study did not show any statistical difference in P_{peak} , the results show a higher value of 5% of P_{peak} for condition C70% compared to condition C, and in the same way when analyzed the individual data nine of the 11 participants presented a value higher P_{peak} condition for the C70% condition. These results are important as previous studies have shown that improvements of 0.5% to 1.5% are considered sufficient to make a difference between competitors in a competitive environment where athletes usually have very similar levels of performance^{7,8}. Many studies examining the potential effects of dark chocolate intake have not focused exclusively on improving exercise performance, but rather on other variables, which are mainly physiological². In the present study, we did not observe any physiological improvements (HR, RPE, GLI, blood pressure) after ingestion of dark chocolate, which is conflicting with previous reported results for these variables^{2,3,6}. These studies attributed the improvement of these variables to the potent effects of polyphenols present in cocoa, which induce the release of nitric oxide and consequently result in vasodilation and prevent the formation of free radicals, leading to direct alteration of these variables^{2,3,6}. Despite using similar amount of dark chocolate according to previous studies, the absence of improvement in these variables in the present study may be related to the duration of the supplementation protocol, as the previous studies that reported improvement used a chronic supplementation

protocol, whereas the present study used an acute supplementation protocol.

Despite the important findings, this study had some limitations such as the low number of participants, the lack of a dietary recall to control and standardize the same diet before the testing sessions; however, it was recommended for the participants to maintain the same diet pattern before each test.

Conclusion

We concluded that supplementation with 80 g of dark chocolate (70% cocoa) ingested two hours prior to the cycle ergometer test to determine the peak power was not able to modify the performance itself nor the physiological and psychophysiological variables evaluated. Although the group analysis revealed no statistical difference in peak power after the acute supplementation of dark chocolate (70% cocoa), individual analysis demonstrated that this supplementation could be used as an ergogenic aid to increase peak power, which demonstrated that after a standardized supplementation the responses are individual, with individual showing large responses and individuals who showed small responses. Other studies should be performed to evaluate different protocols and varying amounts of dark chocolate as well as an individual analysis may potentially be more effective for modifying performance, physiological, and perceptual parameters and to suggest the standardization of protocols to obtain the real ergogenic effect.

Practical Applications

This study serves as a basis for other studies to evaluate possibilities of protocols with dark chocolate supplementation that may be effective in modifying performance as well as physiological and psychophysiological variables. It has also shown that an acute supplementation of 80 g of bitter chocolate (70% cocoa) before the cycle ergometer test can be used as a strategy for improvement in performance. However, its individual effect should be analyzed, as there are responders and non-responders to the potential ergogenic effects of bitter chocolate.

Acknowledgments

The authors would like to thank the chocolate company Copenhagen[®], Maringá-PR,

Brazil, for providing 70% cocoa chocolate for the study. As well as all the subjects who participated in the study.

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