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EFFECT OF PEQUI OIL SUPPLEMENTATION ON BLOOD PRESSURE AFTER A STRENGTH TRAINING SESSION

EFEITO DA SUPLEMENTAÇÃO COM ÓLEO DE PEQUI SOBRE A PRESSÃO ARTERIAL APÓS UMA SESSÃO DE EXERCÍCIO DE FORÇA

Resumo:
O pequi é um fruto típico do cerrado brasileiro. Sua polpa contém antioxidantes e ácidos graxos, cuja ingestão está relacionada à redução da pressão arterial. Contudo, a literatura é escassa quanto ao efeito da suplementação com óleo de pequi sobre a pressão arterial. Objetivo: analisar o efeito da suplementação com óleo de pequi sobre a pressão arterial sistólica e diastólica após uma sessão de treino de força. Métodos: doze homens (21,1±2,6 anos, 77,0±10,5kg) foram submetidos à suplementação com óleo de pequi durante 14 dias. Antes e depois desse período, eles realizaram uma sessão de exercício no supino reto. A pressão arterial foi mensurada em repouso, imediatamente após o exercício, aos 10, 20, 30 e 40 minutos de recuperação. Resultados: tanto antes (+10,6mmHg, P=0,03) como após a suplementação (+13,1mmHg, P=0,02), a pressão sistólica aumentou imediatamente após o exercício. No entanto, não houve redução significativa da pressão arterial sistólica e diastólica em relação aos valores de repouso em nenhum momento, nem antes nem após a suplementação. Conclusão: a suplementação com óleo de pequi por 14 dias é insuficiente para induzir redução da pressão arterial após uma sessão de exercício de força em homens normotensos.

Palavras-chave: óleo de pequi, pressão arterial, treinamento de força

Abstract: *Pequi is a typical fruit of the Brazilian Cerrado. Its pulp contains antioxidants and fatty acids. Intake of these substances is related to lowering blood pressure. However, literature is scarce regarding the effect of pequi oil supplementation on blood pressure. Aim: To analyze the effect of pequi oil supplementation on systolic and diastolic blood pressure after a strength training session. Methods: Twelve men (21.1 ± 2.6 years, 77.0 ± 10.5kg) underwent pequi oil supplementation for 14 days. Before and after this period, they performed a bench press exercise session. Blood pressure was measured at rest, immediately after exercise, at 10, 20, 30 and 40 min of recovery. Results: Both before (+10.6mmHg, P=0.03) and after supplementation (+13.1mmHg, P=0.02), systolic blood pressure increased immediately after exercise. However, there was no significant reduction in systolic and diastolic blood pressure in relation to resting values at any time point, neither before nor after supplementation. Conclusion: Supplementation with pequi oil for 14 days is insufficient to induce blood pressure reduction after a strength exercise session in normotensive men.*

Keywords: *pequi oil, blood pressure, strength training*

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INTRODUCTION

Strength training (ST) is known to promote several physiological adaptations that result in health benefits to humans (PHILLIPS *et al.*, 2017). These adaptations include, but are not limited to, strength gain, body composition improvement (muscle mass gain and reduced fat mass) (BOTTARO *et al.*, 2011) and a protective effect on blood pressure (BP) over time (MACDONALD *et al.*, 2016). Of note, this protective effect of regular ST to blood pressure is related to the so-called post-exercise hypotension phenomenon (PEH) (DUTRA *et al.*, 2013; MOTA *et al.*, 2013). Hence, ST has been suggested as a non-pharmacological strategy to prevent and treat high BP (hypertension) (MACDONALD *et al.*, 2016).

A relationship between hypertension and oxidative stress has been reported in the literature (NAKAMURA *et al.*, 2019). Importantly, oxidative stress is a state of cellular redox imbalance caused by accumulation of oxidative molecules that may cause damage to cells structure (PISOSCHI; POP, 2015). In the cardiovascular system, oxidative stress may lead to endothelium dysfunction and increased BP (NAKAMURA *et al.*, 2019). In this sense, consumption of antioxidant agents such as ascorbic acid (vitamin C) are reported to lower systolic and diastolic BP in short-term trials (JURASCHEK *et al.*, 2012). Furthermore, regular consumption of some fatty acids are related to the reduction of oxidative stress and BP, and can also help to prevent and treat hypertension (NAKAMURA *et al.*, 2019).

Pequi (*Caryocar brasiliense*) is a typical fruit of the Brazilian cerrado. Its pulp contains natural antioxidants, such as carotenoids (α and β carotene) and phenolic acids. Concentration of phenolic acids in pequi pulp is higher (209mg/100g) than many other fruits such as strawberry (132,1mg/100g) and pineapple (21,7mg/100g) (LIMA *et al.*, 2008). Thus, pequi has an elevated antioxidant capacity. In addition, a variety of saturated and unsaturated fatty acids are present in pequi pulp, such as oleic, linoleic and palmitic acids among others (LIMA *et al.*, 2008). Of note, consumption of monounsaturated (oleic acid) and polyunsaturated (linoleic acid) fatty acids is inversely associated to BP (SORIGUER *et al.*, 2003).

It has been recently reported that supplementation with capsules of pequi oil (400mg/day) can effectively attenuate cardiovascular inflammation by reducing hs-CRP levels in Systemic lupus erythematosus patients after 60 days of intervention (MONTALVÃO, 2016). Moreover, it has been shown that pequi oil supplementation (400mg/day during 14 days) reduces plasma lipid peroxidation and DNA damage in runners (MIRANDA-VILELA, A. L. *et al.*, 2009). Worthy of note, Miranda-Vilela and colleagues (MIRANDA-VILELA, ANA L. *et al.*, 2009) showed a significant reduction of systolic and diastolic BP values after only 14 days of pequi oil supplementation (400mg/day) in marathon runners of both sexes.

Altogether, previous results indicate an anti-inflammatory, antioxidant and hypotensive effect of pequi oil supplementation in different populations, including aerobic athletes (runners). However, to the best of our knowledge, no previous research investigated the effect of pequi oil supplementation on BP in a context of ST. Thus, the purpose of the present investigation was to analyze the effect of pequi oil supplementation on systolic (SBP) and diastolic (DBP) blood pressure after a single bout of strength training.

METHODS

STUDY DESIGN AND SUBJECTS

This is a pre-experimental study. Dependent variables (anthropometry, strength, and BP) were assessed before and after 14 days of pequi oil supplementation. Male college students were recruited to participate after the dissemination of posters containing the study protocol information throughout the faculty campus. The following inclusion criterion was adopted: to be male between 18 and 30 years old with previous experience in ST (for at least the last 6 months). Exclusion criteria were: use of any sports supplements; presence of cardiovascular and/or metabolic disease; presence of muscle injury; consumption of pequi fruit more than two times per week.

Fifteen normotensive college students volunteered to participate. All subjects gave written informed consent and were included in the study. However, 3 of them dropped out the study for personal reasons. Thus, the present report presents data from the 12 participants (21.1±2.6 years, 77.0±10.5 kg, 24.3±1.9 Kg/m², 117.4±8.5/68.0±9.5 mmHg) who completed the intervention. All procedures were conducted according to the Helsinki Declaration and the protocol was approved by the Institutional Review Board of the University Center of Brasilia, process number 2.954.476/2018. An overview of the study protocol is presented in Figure 1.

ANTHROPOMETRY AND STRENGTH ASSESSMENT

On the first visit to the laboratory participants underwent anthropometry assessment and strength evaluation. Body weight was measured to the nearest 0.1 kg using a calibrated electronic scale with volunteers dressed in light clothes. Height was determined without shoes to the nearest 0.1 cm using a stadiometer. Body mass index (BMI) was derived as body weight divided by height squared (kg/m2).

Maximal strength test was conducted at the Bench press exercise. Repetition maximum (1RM) was tested using a 9 steps protocol according to the procedures recommended by Baechle e Earle (BAECHLE; EARLE, 2008). A 1RM re-test was performed by each participant 24h after the first test in order to guarantee test reliability. The highest load of the two tests was adopted as 1RM maximal strength.

STRENGTH TRAINING SESSION

The ST session was carried out both before (24h after 1RM re-test) and after the supplementation period at the bench press exercise. Participants were oriented not to consume caffeine rich substances, alcohol and to abstain from exercise for 48h before the ST session. They performed a warm-up set of 15 repetitions at 30% 1RM and rested for 1 minute. Then, 4 sets of 4 to 6 repetitions at 80% 1RM were performed with 1 minute interval between sets. Exercise movement velocity was controlled using a smartphone metronome adopting a cadence of 2 seconds concentric, and 4 seconds eccentric phase.

Figure 1. Overview of the study protocol.

Note: RM repetition maximum.

BLOOD PRESSURE ASSESSMENT

BP measurement was done after a 10 minutes seated rest period on the ST session day (both before and after the supplementation period). Two rest measures were done with 1 minute interval between them. Mean of these measures was adopted as the BP rest value. In addition, SBP and DBP were measured in six more moments: immediately after the end of the exercise, at 10, 20, 30 and 40-min of exercise recovery, as well as 24h after the exercise session. All measurements were done using an oscilometric automatic device (Microlife BP3AC1-1PC). Of note, none of the participants reported to be hypertensive or to use hypotensive medicine.

SUPPLEMENTATION

All participants received a pack containing 14 pequi oil capsules to start the supplementation 72h after de first ST session. Each capsule contained 400mg of pequi oil and should be consumed after lunch, one capsule a day. This dose was used in previous investigations (MIRANDA-VILELA, A. L. *et al.*, 2009; MIRANDA-VILELA, ANA L. *et al.*, 2009; MONTALVÃO, 2016). Subjects received a Bench press exercise prescription to perform during the supplementation period (3 to 4 sets, 8 to 12 reps, 70 to 80% 1RM, 3 times per week). In addition, they were oriented to avoid to eat pequi, and to drink alcohol, coffee, tea, and beverages rich in antioxidants during the supplementation (orange juice, grape juice etc). Except for the mentioned re-

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commendations, participants were oriented to maintain their food and exercise routines during the supplementation period.

STATISTICAL ANALYSIS

Shapiro-Wilk test was performed to assess data normality. As data was parametrically distributed, a two-way repeated measures Anova was used to compare SBP and DBP at all moments before and after the supplementation period. Sidak treatment was used to identify significant differences adopting $P \leq .05$. Data are presented as means and standard deviation. All analysis was performed using the Statistical Package for Social Sciences software (IBM SPSS, IBM Corporation, Armonk, NY, EUA, 25.0).

RESULTS

Sample characteristics before supplementation are presented in Table 1. All participants were normotensive young men with previous experience in ST. It is relevant to mention that bench press 1RM did not significantly change after the supplementation period (75.8 ± 10.6 to 77.0 ± 11.0 kg, $P > .05$).

Table 1. Descriptive characteristics of the sample.

Variable	Mean ± SD
Age (years)	21.1 ± 2.6
Body mass (kg)	77.0 ± 10.5
Heigth (m)	1.78 ± 0.11
BMI (Kg/m^2)	24.3 ± 1.9
Bench press 1RM (kg)	75.8 ± 10.6

Note: BMI body mass index. RM repetition maximum.

Table 2. SBP and DBP (mmHg) response to the ST session before and after pequi supplementation.

	SBP		DBP	
Moments	Before	After	Before	After
Rest	117.4 ± 8.5	117.9 ± 10.2	68.0 ± 9.5	67.2 ± 6.4
Immediately after	128.0 ± 13.4 *	131.0 ± 13.5 *	73.3 ± 12.1	74.2 ± 12.4
10-min recovery	109.8 ± 9.4 §	116.1 ± 4.1 #	63.3 ± 5.8	68.3 ± 9.0 #
20-min recovery	114.4 ± 12.4	121.8 ± 11.0	67.6 ± 9.7	68.5 ± 10.1
30-min recovery	118.4 ± 12.0	117.3 ± 6.7	63.5 ± 8.3	62.3 ± 5.2 §
40-min recovery	114.5 ± 10.6	114.0 ± 9.2 §	67.3 ± 8.3	63.9 ± 12.0
24h after	116.5 ± 9.0	119.2 ± 9.0	68.5 ± 6.5	67.3 ± 5.0

Note: * $P \leq .05$ *vs* Rest. § $P \leq .05$ *vs* Imediately after. # $P \leq .05$ *vs* before.

BP results are presented in Table 2 (absolute values) and Figure 2, panels A (SBP variation) and B (DBP variation).

Both before (+10.6mmHg, *P* = .03) and after the supplementation (+13.1mmHg, *P* = .02), SBP increased immediately after exercise. At pre-supplementation, SBP presented a significant reduction at 10-min recovery in relation to immediately after exercise (-18.2mmHg, *P* = .02). At post-supplementation, this result was repeated at 40-min recovery (-17.0mmHg, *P* = .02). Also, at post-supplementation, DBP presented a reduction (-11.8mmHg, *P* = .03) at 30-min recovery in relation to immediately after exercise. However, there was no significant reduction of SBP and DBP in relation to resting values at any time point, neither before, nor after the supplementation period.

Moreover, BP resting values were not altered after pequi supplementation (Table 2). When comparing the sessions, significance was identified only at 10 minutes after exercise, where SBP (+6.3mmHg, *P* = .04) and DBP (+5.1mmHg, *P* = .02) were higher in the post-supplementation session.

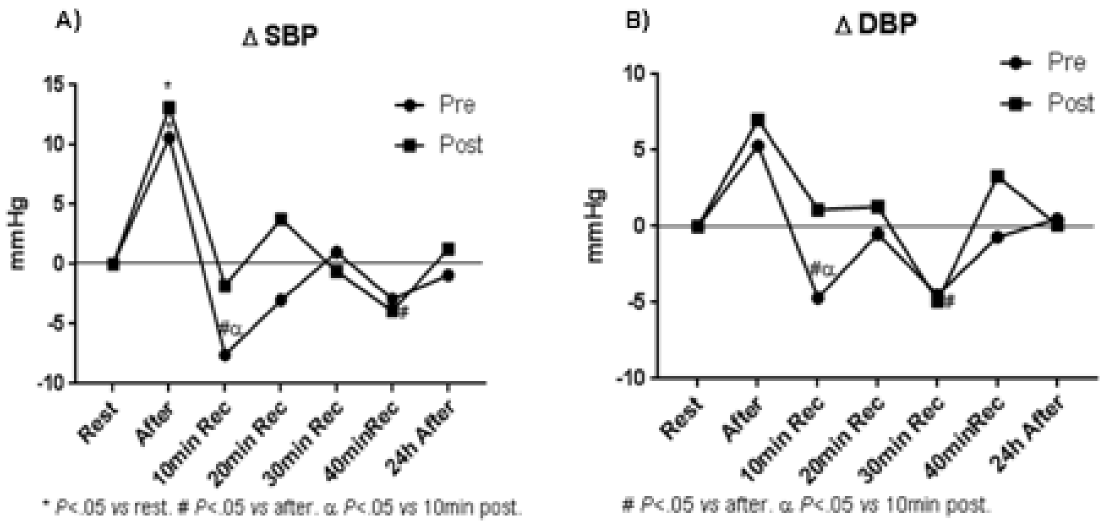
DISCUSSION

The aim of the present investigation was to analyze the effect of pequi oil supplementation on SBP and DBP after a ST session. Interestingly, there was no significant reduction in resting BP values after the supplementation period. In addition, there was no significant reduction in BP at any time point after the ST session, either before or after supplementation.

Initially, such findings differ from those previously reported by Miranda-Vilela et al. (MIRANDA-VILELA, ANA L. *et al.*, 2009). In that study, pequi oil supplementation caused a significant decrease (around 3mmHg) in SBP and DBP in marathon athletes of both sexes after 14 days of supplementation. However, those authors reported that this BP-lowering effect did not occur among younger individuals in their sample (15-44 years), so that the effect of supplementation on BP was greater among runners over 45 years old. In this sense, results of the present study (absence of resting BP reduction) and from Miranda-Vilela are similar with regard to young normotensive individuals.

Once ingestion of mono and polyunsaturated fatty acids (present in pequi oil capsules) is inversely related to BP (MIRANDA-VILELA, ANA L. *et al.*, 2009; SORIGUER *et al.*, 2003), the lack of resting BP reduction observed in this study was not expected and may be related to several factors. Firstly, duration of supplementation was only 14 days. Even though this duration was sufficient to evoke positive effects on lipid peroxidation (MIRANDA-VILELA, A. L. *et al.*, 2009) and even BP (MIRANDA-VILELA, ANA L. *et al.*, 2009) of runners in previous studies, it is possible that the time course of pequi oil

Figure 2. SBP (panel A) and DBP (panel B) variation (mmHg) before (Pre) and after (Post) pequi supplementation.



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action of lowering resting BP is longer. Moreover, participants of the present study were young, physically active and normotensive. It is known that BP reductions induced by strength exercise are more pronounced when basal BP values are high (DUTRA et al., 2013; MORAES *et al*., 2011), such as in elderly, sedentary and hypertensive individuals.

Worthy of note, neither SBP nor DBP were reduced (*P* >.05) in any time point after the exercise session when compared to the resting (pre-exercise) values. This result was the same before and after the supplementation period. In other words, post-exercise hypotension was not observed in the present study. The main reason for this result is probably related to the exercise session volume. It appears that post-exercise hypotension may be influenced by the amount of muscle mass involved in the session. Only one exercise was performed by participants in the present study (bench press, 4 sets, 4-6 reps) and this is a characteristic of low volume exercise sessions. Recent studies have shown that higher exercise volumes are required to induce post-exercise hypotension, such as Bentes et al. (BENTES *et al*., 2017). Those authors reported a hypotensive SBP effect in young individuals after 30 minutes of a strength training session consisting of 6 exercises with 3 sets for each exercise. Furthermore, Freitas *et al*. (2018) (FREITAS et al., 2018) showed that a full body strength exercise session (6 exercises, 6 sets each exercise) is more effective to lower SBP when compared to an upper limb exercise session (3 exercises, 6 sets each) (−10.1±7.4 *vs* −1.9±8.1 mmHg). In other words, a strength exercise session that includes upper and lower body exercises with a larger training volume than the present work is more prone to elicit post-exercise hypotension (FIGUEIREDO *et al*., 2015).

In addition, the cadence adopted in the present research for both exercise sessions with emphasis on the eccentric phase may have been one of the factors for not verifying a lowering BP effect. A recent research showed that eccentric strength exercise elicited a post-exercise hypertensive response in mean BP (around 4mmHg) for 120 min of recovery after the session (STAVRES; FISCHER; MCDANIEL J, 2019). So, it seems like a more metabolic demanding exercise (characteristic of concentric muscle actions) is more effective to elicit the physiological alterations that result in BP reduction after exercise. Some of these physiological factors are reduced cardiac output, reduced sympathetic activity and peripheral vascular resistance (DUTRA *et al*., 2013; HALLIWILL, 2001). However, none of these variables were measured in the present study. Of note, the significant elevation of SBP immediately after the exercise session found in the present study both before (+10.6mmHg) and after (+13.1mmHg) the supplementation is considered to be a normal response related to the cardiovascular demands of the exercise.

Positive effects of pequi oil supplementation in an animal model study were also reported. Oliveira et al. (OLIVEIRA *et al*., 2017) showed that pequi supplementation improved cardiac function by increasing cardiac relaxation and contractility in male rats after 15 weeks. Altogether with previous reports showing anti-inflammatory, antioxidant and a potential hypotensive effect of pequi oil supplementation in humans, including aerobic athletes (MIRANDA-VILELA, A. L. *et al*., 2009; MIRANDA-VILELA, ANA L. *et al*., 2009; MONTALVÃO, 2016), it could be suggested that this supplementation has a different time course of adaptations in the context of ST. As pequi is a largely consumed fruit in Brazilian cerrado, knowledge about its effects in physical activity contexts is welcome.

Furthermore, there are limitations to the present study that could have prevented to find BP reductions after the supplementation period. Main limitation is the lack of a control/placebo group that could provide further comparisons. However, to the best of our knowledge, this is the first study to analyze the effect of pequi oil supplementation on BP in a context of ST. So, findings of the present investigation may add knowledge to the literature. In addition, diet of the participants was not controlled. However, they were all oriented about food and drink habits during the supplementation period.

CONCLUSION

In summary, data from the present study show that 14 days of pequi oil supplementation (400mg/day) does not evoke SBP and DBP reduction in normotensive, strength trained men. Future investigations should be conducted trying to address the limitations of the present study, especially with regard to the experimental design (insertion of a placebo group, closer diet control). Longer duration of supplementation and different ST schemes (higher exercise volume) should also be tested to better elucidate the effect of pequi oil supplementation on BP.

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