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Effect of pequi fruit (*Caryocar brasiliense*) on body composition and blood pressure of physically active adults: a quasi-experimental study

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ABSTRACT

Physical exercise is known to promote several health benefits. Pequi is a very known fruit in the central region of South America. It is argued that pequi oil supplementation may enhance physical exercise adaptations, such as body composition and blood pressure improvement. However, few studies are available on this topic, and they are not conclusive. Purpose: to investigate the effect of pequi oil supplementation combined with physical exercise on body composition and blood pressure of healthy subjects. Methods: Twenty-three subjects (n=13 women, 30.2 ± 5.7 years, 1.66 ± .09 m, 71.5 ± 15.4 Kg) were allocated in two groups: exercise with supplementation (ExeS, n=11) and exercise without supplementation (Exe, n=12). ExeS and Exe performed at least two exercise sessions per week for a period of thirty days. Also, ExeS was supplemented with 400mg/day of pequi oil capsules. Body composition and blood pressure were analyzed before and after the intervention. Differences between groups were assessed by repeated measures analysis of variance adopting P < .05. Results: Body fat percentage did not differ (P > .05) between ExeS and Exe, respectively, before (31.5 ± 11.0 % vs 31.9 ± 9.9 %) and after (30.9 ± 10.5 % vs 31.5 ± 10.6 %) the intervention. Muscle mass and blood pressure also did not present significant changes (P > .05) intra and between groups in both moments. Conclusion: Pequi oil supplementation (400mg/day) for thirty days does not influence body composition and blood pressure of healthy and physically active subjects.

Keywords: ***Pequi oil; Physical exercise; Body composition; Blood pressure.***

Efeito do óleo de pequi (*Caryocar brasiliense*) sobre a composição corporal e a pressão arterial de adultos fisicamente ativos: um estudo quasi-experimental

RESUMO

O exercício físico é conhecido por promover vários benefícios à saúde. Juntamente com a suplementação com óleo de uma fruta muito conhecida na região central da América do Sul, o pequi, argumenta-se que determinadas adaptações ao exercício físico podem ser potencializadas, como a melhora da composição corporal e a redução da pressão arterial. No entanto, poucos estudos estão disponíveis sobre esse assunto e não são conclusivos. Objetivo: investigar o efeito da suplementação com óleo de pequi associada à prática de exercícios físicos na composição corporal e na pressão arterial de indivíduos saudáveis. Métodos: Vinte e três sujeitos (30,2 ± 5,7 anos, 1,66 ± 0,09 m, 71,5 ± 15,4 Kg) foram alocados em dois grupos: exercício com suplementação (ExeS, n = 11) e exercício sem suplementação (Exe , n = 12). O ExeS e o Exe realizaram pelo menos duas sessões de exercícios por semana por um período de trinta dias. Além disso, o ExeS foi suplementado com 400mg / dia de cápsulas de óleo de pequi. A composição corporal e a pressão arterial foram analisadas antes e após a intervenção. As diferenças entre os grupos foram avaliadas por análise de variância de medidas repetidas adotando P <0,05. Resultados: O percentual de gordura corporal não diferiu (P> 0,05) entre ExeS e Exe, respectivamente, antes (31,5 ± 11,0% vs 31,9 ± 9,9%) e depois (30,9 ± 10,5% vs 31,5 ± 10,6%) da intervenção. A massa muscular e a pressão arterial também não apresentaram alterações significativas (P> 0,05) intra e intergrupos em ambos os momentos. Conclusão: a suplementação com óleo de pequi (400mg / dia) por trinta dias não influencia a composição corporal e a pressão arterial de indivíduos saudáveis e fisicamente ativos.

Palavras-chave: ***Óleo de pequi***; ***Exercício físico***; ***Composição corporal; Pressão arterial***.

Efecto del aceite de pequi (*Caryocar brasiliense*) sobre la composición corporal y la presión arterial de adultos físicamente activos: un estudio cuasi-experimental

RESUMEN

Se sabe que el ejercicio físico promueve varios beneficios para la salud. El pequi es una fruta muy conocida en la región central de Sudamérica. Se argumenta que la suplementación con aceite de pequi puede mejorar las adaptaciones al ejercicio físico, como la composición corporal y la mejora de la presión arterial. Sin embargo, hay pocos estudios disponibles sobre este tema y no son concluyentes. Objetivo: investigar el efecto de la suplementación con aceite de pequi combinada con ejercicio físico sobre la composición corporal y la presión arterial de sujetos sanos. Métodos: Veintitrés sujetos (n = 13 mujeres, 30,2 ± 5,7 años, 1,66 ± 0,09 m, 71,5 ± 15,4 kg) se distribuyeron en dos grupos: ejercicio con suplementación (ExeS, n = 11) y ejercicio sin suplementación (Exe, n = 12). ExeS y Exe realizaron al menos dos sesiones de ejercicio por semana durante un período de treinta días. Además, ExeS se complementó con 400 mg/día de cápsulas de aceite de pequi. Se analizaron la composición corporal y la presión arterial antes y después de la intervención. Las diferencias entre grupos se evaluaron mediante análisis de varianza de medidas repetidas adoptando p <0,05. Resultados: El porcentaje de grasa corporal no difirió (p> 0,05) entre ExeS y Exe, respectivamente, antes (31,5 ± 11,0% vs 31,9 ± 9,9%) y después (30,9 ± 10,5% vs 31,5 ± 10,6%) de la intervención. La masa muscular y la presión arterial tampoco presentaron cambios significativos (p> 0,05) intra y entre grupos en ambos momentos. Conclusión: La suplementación con aceite de pequi durante treinta días no influye en la composición corporal y la presión arterial de sujetos sanos y físicamente activos.

Palabras clave: ***Aceite de pequi; Ejercicio físico; Composición corporal; Presión arterial.***

Introduction

Physical exercise is known to promote several health benefits, including muscle mass increase and body fat decrease (FIUZA-LUCES *et al.*, 2013). Also, it is largely demonstrated that both aerobic and resistance exercise reduce resting blood pressure in hypertensive subjects (DUTRA *et al.*, 2009; MACDONALD *et al.,* 2016). According to Dutra *et al.* (2009), normotensive subjects also present post-exercise hypotension. In the past years, several food supplements have been used to boost physical exercise health benefits (WILLIAMS, 2004). Particularly, supplements with antioxidant, anti-inflammatory, and anti-hypertensive properties are amongst the most used, such as vitamins, saturated fatty acids, and others (SENCHINA *et al.,* 2012).

Pequi (*Caryocar brasiliense*) is a very known fruit in the central region of South America. Its pulp is rich in carotenoids, polyphenols, lipids, dietary fiber, zinc, vitamin C, magnesium and others (LIMA *et al.*, 2008; NASCIMENTO-SILVA; NAVES, 2019). The pequi oil (from the fruit pulp and almond) is also rich in some fatty acids, such as palmitic an oleic (NASCIMENTO-SILVA; NAVES, 2019). Recently, evidence has been suggesting that consumption of this oil produces antioxidant, anti-inflammatory, cardioprotective, and hepatoprotective effects (MIRANDA-VILELA *et al.*, 2009; NASCIMENTO-SILVA; NAVES, 2019; VALE *et al.*, 2019). Hence, pequi oil was also tested as a supplement in sports research to increase performance and boost exercise adaptations.

In this sense, there is evidence that pequi oil supplementation may attenuate blood pressure and triglyceride levels of adult runners after only 14 days (MIRANDA-VILELA *et al.*, 2009). Furthermore, evidence of improved cardiac function and liver reduced peroxidation was shown in rats after 15 and 5 weeks of supplementation, respectively (OLIVEIRA *et al.*, 2017; VALE *et al.*, 2019). Hence, it could be hypothesized that pequi oil supplementation may potentiate some of the adaptations to exercise. However, Clael *et al.* (2020) showed no effect of this supplementation on blood pressure, and blood parameters of healthy young men after fourteen and thirty days of intervention.

Thus, even though pequi oil can be very nutritious, the literature is still not conclusive about the potential of its supplementation to enhance exercise adaptations in physically active people. Sample characteristics, duration of the supplementation and daily dosage are still to be cleared with regard to the conditions that boost the influence of this supplementation in physically active humans. So, the purpose of this research was to investigate body composition (i.e., muscle mass and body fat), and resting blood pressure alterations of physically active men and women after 30 days of pequi oil supplementation combined with physical exercise.

Materials and Methods

Study design

This is a *quasi*-experimental trial. The study was registered in the Brazilian Clinical Trials Registry under the number RBR-93qpgnf. Procedures were done according to the CONSORT guidelines. To determine sample size, an *a priori* analysis was conducted using a 0.25 effect size f with $\alpha = 0.05$. It was determined that 34 individuals were needed in the present study for a power of 0.80 (G*POWER 3.1.9.2 Universitat Kiel, Germany). Participants were randomly assigned to two groups: exercise with supplementation and exercise without supplementation. The exercise without supplementation was considered the control group, while the exercise with supplementation was considered the experimental group. Participants from the experimental group were submitted to pequi oil supplementation combined with physical exercise, while control group was submitted only to exercise, both for a period of 30 days. All researchers were aware about group allocation at all stages. The enrollments were voluntary, and all participants gave written consent to participate. Procedures followed the Declaration of Helsinki and were approved by the Institutional Review Board (University Center of Brasilia, process number 3.365.500).

Sample

Inclusion criteria was to be physically active, and to be between 18 and 45 years old. Physical activity level was assessed by the International Physical Activity Questionnaire (IPAQ). Musculoskeletal, cardiovascular, endocrine, and orthopedic diseases, smoking, use of food supplements and medications were adopted as exclusion criteria. Allocation of participants in one of the two groups was done by stratified randomization adopting gender as the factor for stratification. The present study shows data from the twenty-three subjects (30.2 ± 5.7 years, 1.66 ± .09 m, 71.5 ± 15.4 kg) that completed the intervention. Figure 1 presents the flow diagram of the study according to the CONSORT statement (SCHULZ; ALTMAN; MOHER, 2010).

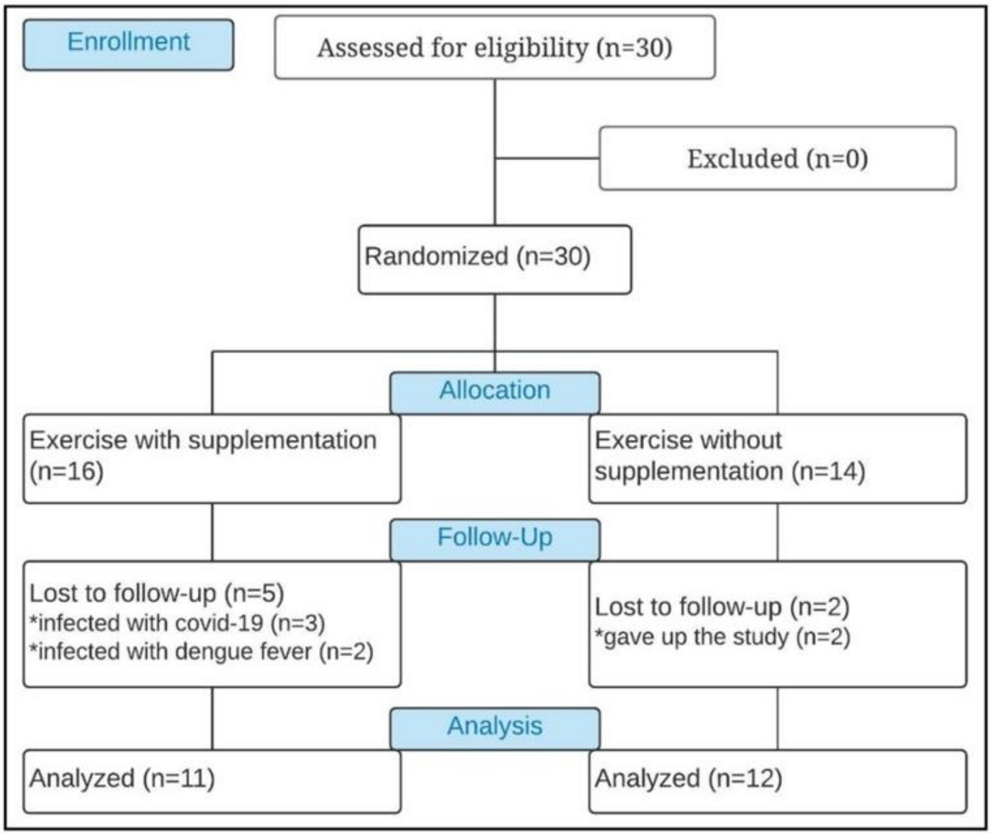

Figure 1. Flow chart of the study.

Experimental Procedures

All participants answered a health, and a physical activity questionnaire (IPAQ) before the intervention. All participants were physically active for at least three months, two times per week, in different exercise modalities, such as resistance training, swimming, running, and tennis. During the study, both groups performed at least two exercise sessions per week for a period of thirty days. Participants were oriented to maintain their training routine. For those who asked for, researchers provided a standard training routine with stretches, strength, and cardiovascular exercises, including push-ups, sit-ups, squat, and stationary running to do at home due to covid-19 pandemic.

Also, the experimental group was supplemented with 400mg/day of pequi oil capsules (Naiak™), one per day, while control was not. They were oriented to take the capsule after lunch and to maintain their dietary habits. Moreover, they were asked to avoid alcohol and antioxidant rich beverages consumption during the study. Adherence to supplementation was checked by counting the remaining capsules in the pack of capsules at the end of the intervention. One day before and one day after the study period (30 days), all participants were submitted to anthropometric, body composition and blood pressure analysis.

Total body mass, body fat and muscle mass percentage were assessed using bioelectrical impedance with a tetrapolar device (Omrom HBF-514, OMRON Healthcare Inc. Lake Forest, IL). Also, this device provides a measure of visceral fat, and this result was compared between groups and reported. Body weight was measured to the nearest 0.05 kg with volunteers dressed in light clothes. Height was measure to the nearest 0.1 cm using a portable stadiometer (Avanutri™). Body mass index (BMI) was calculated as weight divided by height squared. In addition, waist circumference was measured at the level of the umbilicus.

Resting systolic (SBP) and diastolic (DBP) blood pressure, as well as heart rate (HR) were assessed after ten minutes of seated rest using an oscilometric digital device (Omron HEM-7122, OMRON Healthcare Inc. Lake Forest, IL). Three measures were done successively. The mean of the three measures was adopted as the resting blood pressure and HR values. Double product (DP) was estimated as SBP multiplied by HR.

Statistical Analysis

All analyzes were performed using the Statistical Package for Social Sciences (IBM SPSS, IBM Corporation, Armonk, NY, USA, 25.0). The Shapiro-Wilk test was used to verify data distribution. Descriptive analysis was used to present data as “mean ± standard deviation”. A 2x2 analysis of variance was used to compare dependent variables between groups and moments. Bonferroni treatment was used to identify significant differences adopting $P \leq$

.05. Effect size was calculated according to Rhea (2004) when analyzing recreationally trained people. Values < 0.35 are classified as trivial, from 0.35 to 0.80: small, from 0.80 to 1.50: moderate, and >1.50: large.

Results

Recruitment and follow-up were done from January to March 2021. Mean age, height, number of training sessions, and sex distribution in the two groups are presented in **Table 1**. No significant differences were observed (*P* < .05).

Table 1. Characteristics of the sample (mean ± standard deviation) where appropriate.

	Supplementation (n=11)	Control (n=12)
Age (years)	30.4 ± 5.4	30.1 ± 6.2
Height (m)	1.66 ± .07	1.66 ± .1
Training sessions	15.8 ± 6.2	15.9 ± 4.6
Female (n)	6	7
Male (n)	5	5

The experimental group presented a high adherence to the supplementation (98.8%). No significant differences (*P* < .05) were observed between groups both before and after the intervention for SBP, DBP, HR, and DP (**Figure 2, panels A, B, C, and D, respectively**). Also, no differences were observed within each group after the study period. Resting values of all these variables were in normal ranges in both groups.

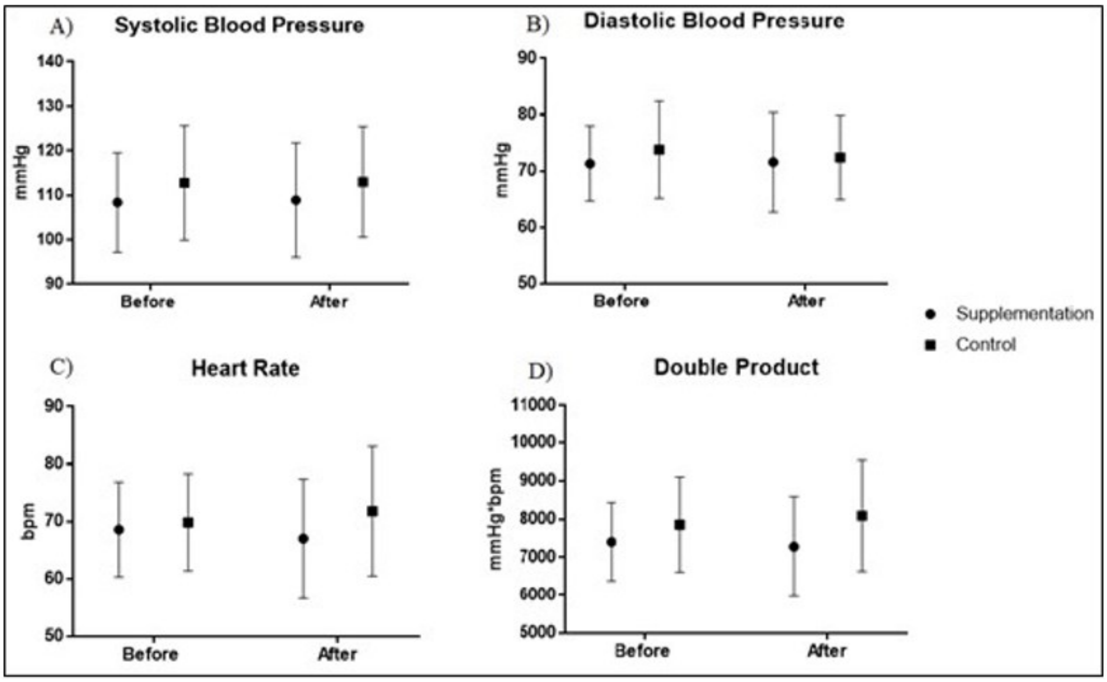

Figure 2. Blood pressure, heart rate and double product before and after the intervention.

No significant differences were observed between both groups before and after the intervention for body weight, body fat percentage, BMI, muscle mass percentage, waist circumference, and visceral fat (**Figure 3**, panels A, B, C, D, E, and F, respectively). Also, no differences were observed within each group after the study period. Participants from both groups were slightly overweighed (mean BMI = 25.9 ± 4.7 kg/m^2 at pre *vs* 25.9 ± 4.4 kg/m^2 at post intervention for supplementation group, and 25.8 ± 5.2 kg/m^2 at pre *vs* 25.9 ± 5.1 kg/m^2 at post intervention for the control group).

For all dependent variables, the effect size was classified as trivial (**Table 2**).

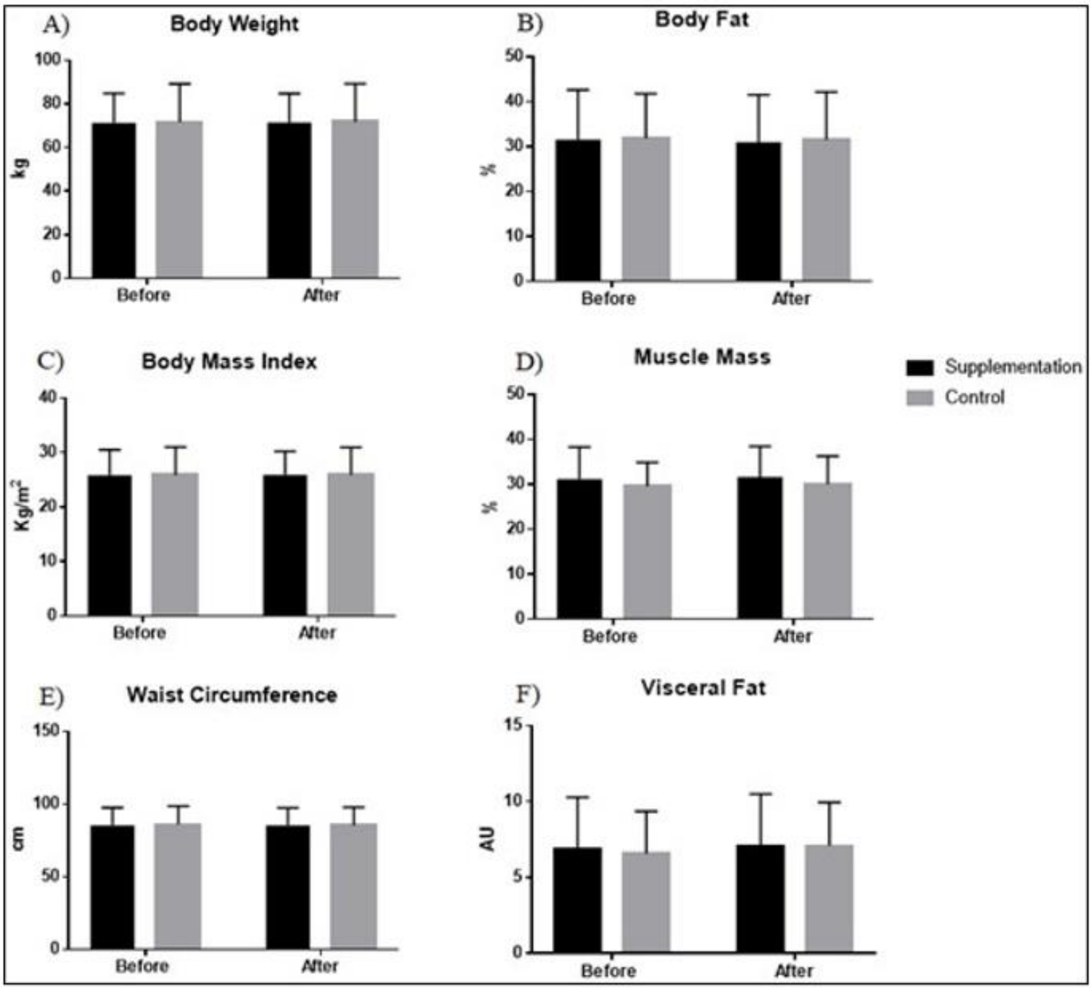

Figure 3. Body weight, body fat percentage, BMI, muscle mass percentage, waist circumference, and visceral fat before and after the intervention.

Table 2. Effect size values for all dependent variables.

Variable	Supplementation (n=11)	Control (n=12)
Weight	0.01	0.01
Body mass Index	0.01	0.00
Waist Circumference	-0.01	-0.05
Body fat percentage	-0.05	-0.03
Muscle mass percentage	0.06	0.08
Visceral fat	0.05	0.18
Systolic blood pressure	0.05	0.02
Diastolic blood pressure	0.04	-0.16
Heart rate	-0.19	0.23
Double product	-0.12	0.19

Discussion

The aim of the present study was to investigate the effect of pequi oil supplementation combined with physical exercise on body composition and blood pressure of healthy individuals. Anthropometric variables like waist circumference and BMI, as well as HR and DP were also assessed. The main finding was that the supplementation did not influence none of the variables analyzed after thirty days of supplementation.

Although previous studies are inconclusive with respect to the influence of pequi oil supplementation on physical exercise adaptations (i.e., body fat and muscle mass percentage, resting blood pressure, and others), it could be expected that some differences between groups could be observed. This is based on the known composition of pequi, a high energetic fruit rich in lipids with high levels of monounsaturated fatty acids (MUFA), proteins, dietary fibers, vitamins, polyphenols, carotenoids, and minerals (LIMA *et al*., 2008; NASCIMENTO-SILVA; NAVES, 2019; TRAESEL *et al.,* 2017). Altogether, these components give antioxidant, anti-inflammatory, and antihypertensive properties to pequi oil. In this sense, not only pequi oil, but also its pulp and almond have been seen as a medicinal food (JUNIOR *et al.,* 2019; NASCIMENTO-SILVA; NAVES, 2019).

Thus, the total absence of significant differences within and between groups at the end of the intervention was not expected given the above mentioned pequi properties. Therefore, in this study, the null hypothesis cannot be rejected. However, unlike the present results, there is evidence that supplementation with pequi oil has positive effects on athletes. In the study developed by Miranda-Vilela *et al.* (2009), street runners of both sexes supplemented with 400 mg of pequi oil daily for 14 consecutive days. Blood collection (lipid profile, complete blood count) and blood pressure were performed before and after the supplementation phase, as well as before and after races. The authors reported that the supplementation resulted in anti-inflammatory effects and lowered LDL cholesterol in runners over 45 years of age. Furthermore, there was a tendency for blood pressure reduction, suggesting a possible hypotensive effect of the supplementation.

In addition, previous investigations using the same dosage of the present study showed that pequi supplementation for 14 days may also attenuate DNA damage in runners (MIRANDA-VILELA *et al.,* 2009), as well as diminish inflammation measured by high sensitive C-reactive protein in a sample of chronic inflammatory disease patients after 60 days of intervention (MONTALVÃO *et al.*, 2016). In an animal model, a previous study showed that pequi oil supplementation for 5 weeks promoted a protective effect on the hepatic tissue by reducing lipid peroxidation after swimming exercise (VALE *et al.*, 2019).

Altogether, these results suggested that pequi oil supplementation may be beneficial to aerobic exercise practitioners such as marathon, especially from the point of view of its acute effect in reducing cell damage and cardiovascular protection, which may lead to improved performance. However, the present investigation did not corroborate those studies, as no effect of the supplementation was observed in any of the dependent variables both within and between groups. Interestingly, this is consistent with previous studies that analyzed young, healthy, and physically active people after 14 and 30 days of supplementation combined with resistance exercise and did not show any effect of the supplementation in acute and chronic SBP, DBP, HR, DP, as well as total cholesterol, triglycerides, and acute blood lactate, rate of perceived exertion and 24-hour muscle soreness (CLAEL *et al.,* 2020; DUTRA *et al.*, 2019; LEITE *et al.*, 2020).

The lack of differences observed in the present study can be explained by some factors. Firstly, the sample consisted of relatively young adults, physically active and free of chronic and inflammatory diseases. In this sense, the physiological parameters analyzed were already within normal limits, making it difficult to be reduced (DUTRA *et al.,* 2013). Possibly, a longer-lasting intervention, longer than thirty days, in older individuals and/or people with chronic diseases is necessary to induce changes related to supplementation, if any. Secondly, the study sample is small. This is a limitation of the study and it was partly caused by the suspension of face-to-face activities due to the

COVID-19 pandemic, making it difficult to attract and retain volunteers to the research.

Another possible explanation to the results is related to the physical exercise. In fact, this is another limitation of the study because there was no strict control of exercise intensity and volume. Of note, participants were oriented to maintain their exercise routine during the study and all of them reported to do mixed exercise sessions, with both aerobic and resistance exercises. It is known that intense physical activity can increase reactive species, generate stress and oxidative damage and, therefore, induce greater fatigue during exercise. Also, antioxidant supplementation could reduce fatigue during exercise (REID, 2016), and pequi oil has various antioxidants in its composition. However, as exercise intensity was not tightly controlled during the study, it is hard to say if the sessions were enough stressful to induce an antioxidant action from the supplementation. Noteworthy, all participants were used to both aerobic and resistance exercise, and there were no differences between groups regarding the number of training sessions performed (**Table 1**).

Conclusions

In summary, pequi oil supplementation (i.e., 400mg/day) for 30 days has no impact on anthropometrics, body composition, and blood pressure of physically active men and women without chronic diseases. As pequi is still very consumed in the region (central South America), future studies are welcome to try to elucidate the circumstances regarding exercise, supplementation dosage, and sample characteristics, in which the supplementation can potentiate morphologic and physiologic adaptations related to exercise.

Acknowledgements

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