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Artigo Original

Effect of ginger on the lower limb anaerobic power of brazilian national team gymnasts

Efeito do gengibre no poder anaeróbico de membros inferiores de ginastas da seleção brasileira

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ABSTRACT

Introduction: Aerobic gymnastics is a sport that has consistently grown over the previous decades, and its practice demands its athletes to perform complex and high-intensity movements. **Objective:** Study was to analyze whether ginger supplementation had an ergogenic effect on the anaerobic power of limbs (PAMI) in aerobic gymnastic athletes. **Methods:** A randomized double-blind placebo-controlled trial was conducted with nine athletes (23.11 + 4.14 years, 1.63 + 0.09 m, 60.51 + 7.38 kg) from the Brazilian National Team of Aerobic Gymnastics. After ingesting 400 mg of *Zingiber officinale* or placebo for seven days, the subjects underwent an anaerobic power test (RAST). Peak Velocity and Peak power (m/s and W), average and minimum power (W) and fatigue index (W/s and %) data were obtained from the RAST. **Results:** After verifying the no normality of the sample, the Mann-Whitney was applied, but no significant differences were found in the peak velocity of the ginger supplementation (6.28 ± 0.41 m/s; 445.28 ± 117.15 W) compared to placebo (6.22 ± 0.45 m/s; 425.95 ± 130.39 W). **Conclusions:** It is concluded that ingesting 400 mg of *Z. officinale* does not have an ergogenic effect on the anaerobic power of the lower limbs of aerobic gymnastic athletes.

Keywords: Ergogenic Effect; Gymnastics Aerobics; Phytotherapeutic; Strength.

RESUMO

Introdução: a ginástica aeróbica é um esporte que tem crescido consistentemente nas últimas décadas, e sua prática exige que seus atletas realizem movimentos complexos e de alta intensidade. **Objetivo:** analisar se a suplementação com gengibre tem efeito ergogênico no poder anaeróbico dos membros (PAMI) em atletas de ginástica aeróbica. **Métodos:** foi realizado um estudo randomizado, duplo-cego, controlado por placebo, com nove atletas (23,11 + 4,14 anos, 1,63 + 0,09 m, 60,51 + 7,38 kg) da Seleção Brasileira de Ginástica Aeróbica. Após a ingestão de 400 mg de *Zingiber officinale* ou placebo por sete dias, os indivíduos foram submetidos a um teste de potência anaeróbica (RAST). Os dados de Velocidade de pico e Potência de pico (m/s e W),

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potência média e mínima (W) e índice de fadiga (W/s e %) foram obtidos no RAST. **Resultados:** Após verificar a não normalidade da amostra, foi aplicado o Mann-Whitney, mas não foram encontradas diferenças significativas na velocidade de pico da suplementação de gengibre (6,28 ± 0,41 m / s; 445,28 ± 117,15 W) em comparação ao placebo (6,22 ± 0,45 m / s; 425,95 ± 130,39 W). **Conclusões:** conclui-se que a ingestão de 400 mg de Z. *officinale* não exerce efeito ergogênico no poder anaeróbico dos membros inferiores de atletas de ginástica aeróbica.

Palavras-chave: Efeito Ergogênico; Ginástica Aeróbica; Fitoterapêutico; Força.

INTRODUCTION

Aerobic gymnastics is a non-Olympic sport that has consistently grown over the previous decades, and its practice demands its athletes to perform complex and high-intensity movements following musical patterns[1]. These movements are related to aerobic and anaerobic power, strength and flexibility[2].

High-intensity training is a type of exercise that induces inflammation, which promotes tissue repair and remodeling[3], this is associated with increased damage-associated molecular patterns (DAMPs) and the innate release of pro-inflammatory cytokines, such as TNF -α and IL-6, and enzymes such as cyclooxygenase (COX) -1 and 2, substances that promote late muscle pain and decrease performance[3,4]. In response to exercise, the synthesis of inflammatory cytokines, such as TNF-α, is regulated by different signaling pathways, including the COX-prostaglandin cascade[5]. Studies have analyzed the use of drugs by athletes in order to promote the inhibition of these inflammatory processes[6,7,8]. Through their inhibitory effect on COX-1 and COX-2 enzymes, nonsteroideal anti-inflammatory drugs (NSAIDs) have been shown to reduce inflammatory responses that occur in the acute recovery phase of exercise[9]. However, the use of NSAIDs by athletes aiming at an ergogenic effect leads to a series of acute and chronic concerns, since these drugs can cause gastrointestinal pain and hemorrhage, hepatitis and anaphylactic reactions[10]. This is because NSAIDs have an effect on two COX isoenzymes; the COX-2 isoenzyme is associated with edema and pain perception[11], while the COX-1 isoenzyme plays an important role in the synthesis of prostaglandins through a protective function of the gastric mucosa[11].

An alternative to NSAIDs is the use of phytotherapeutic compounds such as ginger[12]. Studies evaluating the effect of ginger in vitro, humans and rodents, show that it affects the isoenzyme COX-2[13], which has an anti-inflammatory effect mediated by the inhibition of macrophages and neutrophils and negatively controls the migration of neutrophils and leukocytes, such as evidenced by the dose-dependent decrease in chemokines and pro-inflammatory cytokines, such as TNF-α[14] and C-reactive protein[15] and by the replacement of the total antioxidant capacity[16]. This, in turn, has a direct effect on COX-2 inhibition[17, 18, 19]. Unlike NSAIDS, the specific action of ginger on COX-2[13] would increase the synthesis of leukotrienes and prostaglandins, thereby promoting gastric function[20]. Because of all of these functions, ginger is used in treating inflammatory diseases, such as arthritis and rheumatism, diseases of the nervous system, gingivitis and diabetes[21].

Different investigations have analyzed the effect of ginger supplementation on subjects who underwent training programs with the objective of proving a possible ergogenic effect. Thus, different studies corroborate the effect of supplementation in individuals with low level of physical fitness, such as obese subjects undergoing high intensity interval training (HIIT) programs, which showed a decrease in interleukin 6 and increased aerobic capacity[22], or strength training that showed the decrease in the percentage of body fat, body fat mass, total cholesterol mass and insulin resistance[23]. On the other hand, research carried out in populations with a moderate level of training analyzed the effects of ginger supplementation on variables such as decreased potency levels, pain perception, late-onset muscle pain (DOMS) and / or damage-marking enzymes muscular. after a standard resistance training session[18,24] or a long distance run[10], and show a positive effect accelerating recovery. Because no research has focused on the effect of ginger supplementation on highly trained athletes or on efforts with a high glycolytic component, this study aimed to analyze whether ginger supplementation had an ergogenic effect on the anaerobic power of lower limbs (APLL) performance in aerobic gymnastics athletes.

METHODS

A randomized double-blind placebo-controlled trial was conducted with nine athletes from the Brazilian Aerobic Gymnastics team: four males and five females. The project was approved by the Ethics Committee of the Federal University of Lavras under CAAE protocol number: 67813817.1.0000.5148. Table 1 presents the physical characteristics of the subjects.

The study was divided into three parts. The first part was developed in the Laboratory of Sports Nutrition, located in the Department of Nutrition (DNU), and the other two parts were developed in the Laboratory of Human Movement Studies (LEMOH), located in the Department of Physical Education (DEF).

The athletes were evaluated in a placebo-controlled crossover trial with a seven-day washout period[25]. The first part of the study consisted of an anthropometric evaluation and signing of the TCLE. Next, there was a 24 h interval before beginning the second part of the study supplementation with either ginger or placebo for seven days. At the end of the seventh day PAMI was evaluated through the running anaerobic sprint test (RAST) following the protocol used by[26]. After a washout period of seven days, the groups were crossed, and supplementation immediately began, lasting for seven days. After the last day, PAMI analysis was again performed (Image 1).

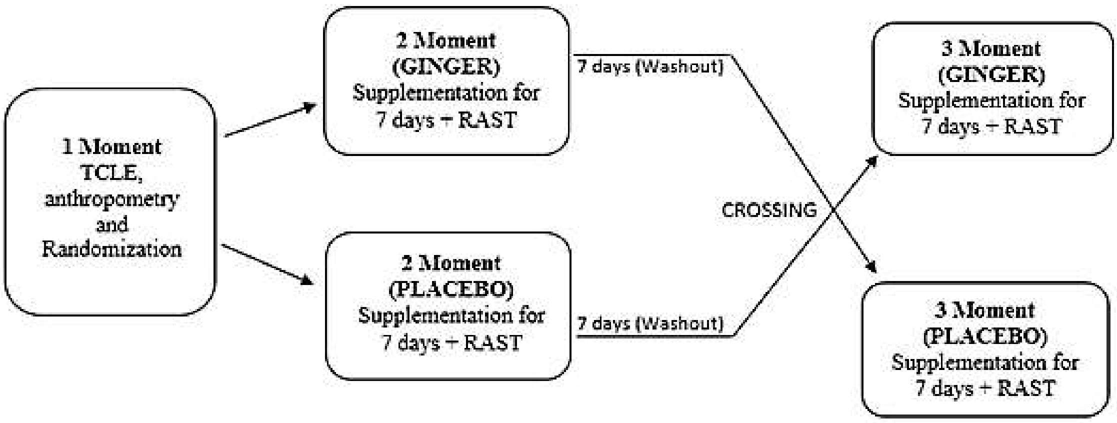
For seven days, the athletes ingested a 400 mg (0.35% total gingerols) capsule of ginger extract (*Zingiber officinale*) or placebo (400 mg starch) taken daily in the morning with water. The capsules were made in a pharmacy that was accredited by the Regional Pharmacy Council of Minas Gerais/MG. Gelatin size 1 capsules in red and white colors were used for both ginger and the placebo, following parameters stipulated by[27]. On the seventh day of supplementation, the athletes performed the physical tests. The athletes were instructed to maintain their usual dietary intake during the study period. They were also instructed to eat the same meal on the days of the physical tests.

Table 1. Physical characteristics of the study participants (n = 9)

PHYSICAL CHARACTERISTICS	FEMALE	MALE	ALL
Age (years)	20.00 ± 1.41	25.60 ± 3.91	23.11 ± 4.14
Height (m)	1.55 ± 0.05	1.70 ± 0.03	1.63 ± 0.09
Weight (Kg)	55.37 ± 6.22	64.62 ± 5.71	60.51 ± 7.38
Body Mass Index (Kg/m²)	23.22 ± 3.11	22.32 ± 1.85	22.83 ± 2.14
Body Fat (%)	22.75 ± 7.11	10.28 ± 2.48	15.82 ± 8.7

Legends: M: Average; S: Standard deviation; %: percentage; Kg/m²: kilogram per square meter; m: meter; Kg: kilogram.

Image 1. Experimental design



Legends: TCLE: Informed consent form; RAST: Running anaerobic sprint test

To characterize the sample, height and body mass data were collected from a scale with a stadiometer (110 FF, Welmy®, Santa Bárbara d'Oeste, Brazil). The percent body fat was determined using the multifrequency octapolar InBody apparatus (Biospace, model 230 - InBody Body Composition Analyzers, Korea), the sample was instructed to fast for at least 4 hours, do not perform intense physical activity in the 24 hours prior to the test, urinate at least 30 minutes before, do not consume alcoholic beverages in the previous 48 hours and do not use diuretics for 7 days before.

Prior to RAST assessment protocol initiation, a standard warm-up was performed in which the volunteers performed 20-s sustained limb stretching and subsequently completed a light 3-min running slowly after an interval of 1 min. The RAST consisted of six 35 m sprints, interspersed by a passive recovery period of 10 s. The time was recorded for each effort (Timex®, model 85103). The absolute power (Pabs), in Watts (W), was determined in each run by measuring the time (t), distance (D) and body mass (BM) of the individual (Pabs (W) = (BMxD2)/t3). RAST variables were determined, including the peak velocity (PV), peak power (PP), mean power (MP) and minimum power (MinP), and are represented both in units relative to body mass (REL) and in absolute values (ABS). The fatigue index (FI) (FI (%) = (PP – MinP) x 100)/ PP) was also calculated. In addition, the maximum velocity (VMAX) and the mean velocity (VMEAN) were determined through the relationship between distance and effort time[28].

All variables are presented as the mean (M) and standard deviation (SD), along with the coefficient of variation (CV) expressed as a percentage. The Shapiro-Wilk test was applied to verify the normality of the data. As the assumptions of normality do not were met, the Mann- Whitney test was used to compare the two stages of the study (ginger and placebo), and for analyzing variation among the data, the Δ test was used. The effect size (ES) was calculated according to Cohen's d. The level of significance (α) was set at 5%. It was also used Magnitud-based inferences. Statistical processing was performed with the SPSS software (21.0, IBM, Armonk, USA).

RESULTS

Image 2 shows that there were no significant differences when comparing PV (m/s) after ginger supplementation relative to placebo (6.28 ± 0.41 m/s vs. 6.22 ± 0.45 m/s, p = 0.645, ES = 0.006).

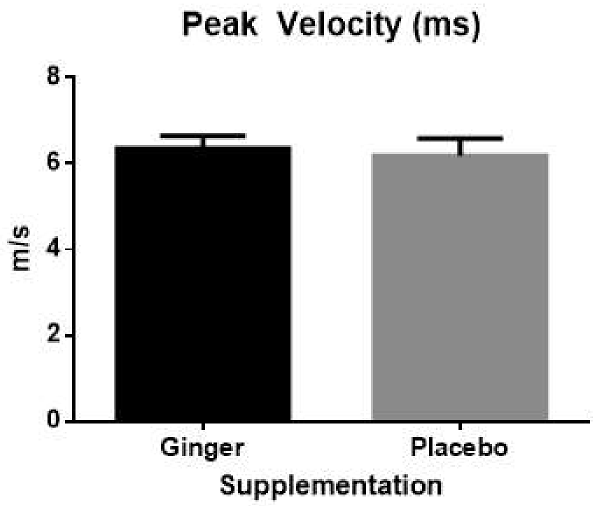


Image 2. Levels of PV (m/s) obtained after ginger supplementation vs. placebo.

Legends: Peak Velocity; m/s: meters per second

Table 2. Comparison of velocity, power levels and fatigue index after supplementation with ginger vs. placebo.

Variable	Ginger		Placebo		Δ variation (%)	p-value	ES
	M ± SD	CV (%)	M ± SD	CV (%)			
PV (m/s)	6.28 ± 0.41	6.60	6.22 ± 0.45	7.23	0.96	0.382	0.057
PP (w)	457.76 ± 70.29	12.83	432.22 ± 89.98	18.04	5.91	0.442	0.038
AP (w)	365.37 ± 63.11	17.27	342.50 ± 59.25	15.84	6.68	0.382	0.028
MP (w)	280.60 ± 47.48	16.92	263.33 ± 60.84	13.30	6.56	0.279	0.028
FI (w/seg)	4.77 ± 0.76	15.30	3.75 ± 0.81	21.6	27.2	0.065	0.322
FI (%)	12.13 ± 1.63	15.30	13.75 ± 2.11	15.34	-11.78	0.195	0.172

Legends: M: Average; S: Standard deviation; PV: Peak Velocity; PP: Peak Power; AP: Average Power; MP: Minimal Power; FI: Fatigue Index; Δ: Delta; ES: Effect Size.

Likewise, no significant differences were observed between the two experimental conditions in the following variables: PV, PP, MP, MinP (W) or FI (Table 2).

DISCUSSION

Our findings showed that there was no significant difference when comparing the placebo and ginger groups. When analyzing the APLL, there was no significant difference between the ginger and placebo groups in terms of the PV and PP (m/s and Watts), mean (Watts) and minimum (Watts) power variables.

The test used in the present study included a high-intensity race, an exercise modality that includes eccentric high-intensity actions, which has been shown to generate a greater inflammatory response and muscle damage than other modalities such as the cycloergometer[29]. After this type of exercise, both inflammation and pain perception are considered good indicators of muscle damage[30]. Two previous studies evaluated the effect of ginger supplementation on running[10, 27]. In the first investigation, aimed to demonstrate the effect of supplementation with 2.2 g/day of ginger compared to placebo in a sample of subjects trained in a crossover study on DOMS, as well as on loss of performance in a countermovement jump (CMJ) after a 20-22-mile race at training pace[10]. The decrease in CMJ jump height shortly after finishing the exercise compared to the previous values was considered a good indicator of muscle fatigue[31, 3(ii2]. In that study, the researchers found that ginger supplementation had a positive effect on DOMS reduction and had no effect on muscle fatigue, since it did not attenuate the loss of performance in CMJ. Subsequently, the same group of researchers[27] also did not observe any effect of ginger supplementation (1.425 g/day) in runners in muscle fatigue (analyzed by the decrease in performance in CMJ) after a 40-min incline test; however, it was effective in reducing DOMS.

The results of the previous studies[10, 27] coincide with the findings which showed that supplementation with 2 g/day ginger had a positive effect on pain reduction according to a visual analog scale (VAS) compared placebo after performing an eccentric training session consisting of three sets of six repetitions with a duration of 3 s and a load of 120% of one-repetition maximum (1RM)[24]. However, in that study, no effect of supplementation on the recovery of maximal isometric power levels of the arms was observed, both at the end of the training and at 72 h after completion.

The demonstrated inefficiency of previous investigations of ginger supplementation in reducing neuromuscular performance loss after an exercise protocol[10, 24, 27]are in agreement with the absence of improvement found in our study after supplementation. These results may occur due to the lack of effects of ginger in preventing muscle catabolism during physical exercise, which may explain results that showed no effect of supplementation with 4 g/day of ginger for five days to minimize increased muscle damage marker enzymes such as creatine kinase (CK) and lactate dehydrogenase (LDH) after an eccentric training session for the upper limbs[18]. DOMS is related to muscle damage[3], and supplementation with ginger may have an effect on DOMS and pain perception in the absence of different responses in muscle structures. Thus, the effect of ginger supplementation on the COX-2 isoenzyme, inflammatory cytokines and leukotriene synthesis could block the increase in mechanical muscle tissue hypersensitivity by reducing the activation of type III and IV afferent nerves due to bradykinin and sensitization of afferent fibers by prostaglandins and inflammatory cytokines interleukin 1 and 6 (IL-1 and IL-6)[24]. Moreover, different components of ginger act as agonists of transient receptor potential cation channel subfamily V member 1 (TRPV1) receptors[16], which participate in nociception and pain perception[16]. Thus, chronic supplementation could reduce the sensitivity of nociceptive receptors to mechanical and chemical stimuli[14], possibly through the depletion of substance p[19].

Although ginger supplementation can have positive effects in reducing DOMS, reducing the activation of type II and IV[24] afferent nerves and their agonist action on TRPV1[24] receptors, these effects are not able to have a positive effect on the performance of a PAMI test, as found in the results of the present investigation and recovery from exercise[10, 24, 27]. Other studies have not found an ergogenic effect of ginger supplementation in combination with a long-term training program (10 weeks) compared to placebo training on the variables of body composition and fitness[22, 23].

CONCLUSIONS

Long-term ginger supplementation is safe; however, the present study demonstrated that ginger has no effect on the anaerobic power of the lower limbs or the fatigue index in aerobic gymnastic athletes. The data found with this population highlights that supplementation with ginger cannot be considered an ergogenic nutritional aid in sport.

CONFLICT OF INTEREST DISCLAIMER

The authors declare that they have no conflict of interest.

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