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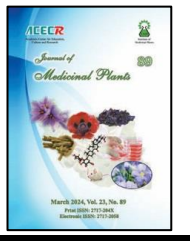

Research Article

The effect of *ginger* supplementation on inflammatory indicators and muscle damage after eccentric and concentric exercise in obese girls

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ABSTRACT

Background: Some activities, such as acute activity, can cause an increase in inflammatory indicators and muscle damage in the blood. **Objective:** The aim of the effect of taking *ginger* supplement along with acute extroverted and introverted activity was on some inflammatory indicators and muscle damage in the serum of obese girls. **Methods:** After measuring the maximum oxygen consumption, 50 girls with a body mass index of over 30 kg/m2, age 24.89 ± 73.7 years, height 159.02 ± 5.20 cm and weight 87.77 ± 88.8 kg were randomly divided into 5 groups including: experimental group 1 [supplement+ extrovert (n = 10), experimental group 2 [supplement + introvert] (n = 10), placebo + extrovert group (n = 10), placebo + introvert group (n = 10)b , and control group (n = 10) became The training protocol included acute extroverted and introverted activity [positive and negative incline on the treadmill] was implemented. Supplement groups consumed 2 grams of *ginger* powder daily for 4 weeks. After fasting for at least 8 hours, blood samples were collected before and immediately after any type of activity to measure serum hs-CRP and ck levels. To examine intra-group changes, t-dependent and for inter-group comparisons, analysis of covariance with inter-group factor was used (P = 0.05). **Results:** The t-dependent results of this research showed that acute extroverted and introverted exercise in the pre-test and post-test, respectively, caused a significant increase in the levels of hs-CRP and CK in the supplement and placebo groups ($P \leq 0.05$). Also, the results of covariance analysis showed that taking *ginger* supplement for four weeks after acute extroverted and introverted activity had a significant effect on hs-CRP levels (P = 0.04) between supplement and placebo groups. CK levels (P = 0.09) had no significant effect between the supplement and placebo groups. **Conclusion:** Increased levels of inflammation and muscle damage in introverted acute exercise are greater than in extroverted. According to the results of this research, daily consumption of *ginger* supplements can reduce inflammation and muscle damage caused by physical activity.

1. Introduction

Obesity is a multifaceted and complex disease that involves many tissues of the body [1]. The studies have shown that the prevalence of obesity in all age groups is increasing and this increase is significantly higher in women than in men [2, 3]. Obesity refers to excessive or abnormal accumulation of fat in adipose tissue [4]. Obesity increases the risk of bone diseases, cardiovascular diseases, type 2 diabetes, high blood pressure, and dyslipidemia [5]. Also, weight gain and obesity have a direct relationship with inflammation [6]. In this situation, hs-CRP, which is one of the

Abbreviations: HRmax, heart rate; BMI, body composition index

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inflammatory indicators in the blood, increases [7]. Physical activity also affects inflammatory responses in healthy people [6]. One of the best and most appropriate ways to lose weight and improve body composition is to participate in a sports program. Studies in recent decades show that the implementation of acute introverted and extroverted exercises, apart from the fact that it has undeniable beneficial effects on the strength of the skeletal muscle system, has always raised concerns about possible damage to these systems, which results in sarcomere damage and the expansion of the stress response. And there has been inflammation [8]. In this regard, some researchers have stated that physiological stress and tissue damage caused by extroversion and introversion of muscles lead to an increase in the number of so-called shock protein factors, which are known as stress proteins and cell heat guards 1 [HSP] and play an important role in normal and under stress cells. They both play a role in stress [9, 10] and cause cell maintenance and protection against all types of stress and tissue damage [11]. Muscle damage leads to cell damage, membrane destruction, leakage of materials outside the cell, and an increase in the concentration of creatine kinase [CK] enzyme in the blood [12]. Researchers have used various methods, including the use of antioxidant supplements, to reduce inflammation and pain caused by eccentric exercise. Therefore, one of the proposed methods is the use of medicinal plants, including *ginger*, which can be an effective way to reduce inflammation and muscle damage caused by physical activity. *Ginger* is one of the medicinal plants used in traditional medicine to treat inflammatory diseases and reduce pain [13]. The *ginger* plant belongs to the Zingiberaceae family. This plant is the dried creeping and tuberous rhizome of *Zingiber officinal* Roscoe. This plant is one of the oldest medicinal plants in medical science, especially in the treatment of inflammation [13]. It is among the medicinal plants that are widely cultivated in different regions of Asia, and Iranians used this plant in ancient medicine to reduce inflammation and edema [14]. Regarding the anti-inflammatory effects of this plant, many reports have shown that the active compounds of this plant such as gingerol, and chogolocurcum can produce prostaglandin and anti-inflammatory indicators [15]. Therefore, the anti-inflammatory effect of *ginger* may be caused by reducing the formation of prostaglandins, which are effective in the occurrence of pain and bruises [16]. Gingerol-6 is one of the derivatives of *ginger*, which has high antioxidant properties [17]. In the present study, the results obtained in line with other studies showed that performing introverted and extroverted activities increases inflammatory indices and muscle damage after extroverted activities. These results were consistent with the findings of Bije et al., (2010) and Ahmadi et al., (2018) [18, 19]. Simar et al., 2012, showed a decrease in HSP72 levels after taking antioxidant supplements [20]. Several animal and human reports show that *ginger* has anti-inflammatory, antioxidant, and antitumor properties [21, 22, 23]. Black et al. [2010] showed a reduction in inflammation after supplementing with *ginger* [24]. By reducing the inflammatory effect, *ginger* can be an effective treatment method for obese people. Due to the lack of research on the effect of the type of muscle contractions caused by extroverted and introverted exercises on the level of inflammatory factors along with supplement consumption, this study aims to evaluate and investigate the effect of *ginger* supplement consumption along with extroverted and introverted acute activity on hs-CRP and

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creatine. Serum kinase was performed in obese girls.

2. Materials and methods

2.1. Sports protocol

This research is a semi-experimental method of applied type with a code of ethics ir.medilam.rec.1395.192, and the statistical population of this research consisted of obese girls. After the announcement of the call, 100 people applied to Ilam University of Medical Sciences, and from this number, based on the formula for determining the sample size [n=[[SD12 +SD22] × [Z1-a/2 +Z1-b]2]/D2], 50 people who met the criteria they were selected by purposive sampling method. Absence of history of specific diseases, no use of drugs, history of physical activity, BMI ≥ 30 kg/m2, and age range of 23-25 years were considered as entry criteria (Table 1). The criteria for leaving the research were also not following the recommendations of the researchers not attending the exercises regularly or taking drugs, and none of the people were removed for this reason. All the people were healthy and according to the opinion of the general physician, they did not have any restrictions to participate in the activity. The sports activity of this research included two sessions of eccentric and concentric exercises on the treadmill. One week before the start of the test, the subjects did the eccentric and concentric test to familiarize themselves with how to perform it. After learning how to do the exercises and completing the research consent form, the subject's height, weight, as well as their body composition, and body fat percentage were measured using an electrical bioimpedance device [model 3.3, Olympia, made in South Korea], and the maximum Their oxygen consumption was calculated through the block test on a treadmill and the people were homogenized in terms of aerobic capacity [25]. After screening and selecting the research samples, the subjects were divided into 5 groups: experimental group 1 [supplement + external] [n = 10], experimental group 2 [supplement + concentric] [n = 10], placebo + external [n = 10], the placebo+concentric group [n=10] and the control group [n=10] were divided. Subjects of the experimental group received one gram of *ginger* capsule [Zintoma] daily in doses of 250 grams, 2 servings per day [before lunch and dinner] for 4 weeks. *Ginger* capsules [Zintoma] were obtained from Gol Daro herbal medicinal products company with health license 1228022777 IRC from the Department of Food Supervision of the Ministry of Health. The supplement groups took *ginger* supplements for four weeks. Placebo groups used capsules containing starch [placebo] during these four weeks. The control group did not take any supplements and did not exercise during these four weeks. After four weeks of supplementation and placebo, the groups performed eccentric and concentric exercises. The subjects of the study performed eccentric and concentric exercises using a treadmill [Cosmuse/hp, Saturn model, made in Germany] using the Elsted protocol according to Table 2 until exhaustion [26]. Subjects in the eccentric group ran with their backs to the treadmill and subjects in the concentric group ran facing the treadmill. The training was done between 7:30 and 9:30 in the morning. The maximum heart rate of subjects at rest and before exercise was calculated based on the Karonen equation [HRmax-220 age] and during exercise using a heart rate monitor [Polar model made in Finland] which was installed on the subject's chest and displayed on the screen of the treadmill. It was observed and controlled.

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Having at least two of the three conditions for stopping exercise [declaring the individual's inability to continue the activity a test score above 16 from Burke's pressure perception scale and a heart rate higher than [HRmax] was considered as the end of the test. The subjects of both groups previously warmed up for five minutes from the beginning of the exercise. To avoid the effect of the type of food consumed on the results of the research, all the meals on the day before the test were distributed equally to all the subjects, and also to avoid the effect of the feeling of people falling off the floor. Treadmill based on the time and level of fatigue caused by exercise, a protective vest attached to the treadmill and attached to the upper body of the subject was used, and the treadmill stopped with the slightest deviation of the person from the straight path.

Table 1. Anthropometric characteristics, physical and physiological composition of subjects

P*	Groups				Characteristics of subjects
	Control	Placebo + Concentric exercise	Supplement + Concentric Exercise	Supplement + Eccentric training	
0.80	25.16 ± 11.31	24.63 ± 9.41	24.66 ± 9.01	24.86 ± 2.1	Age (years)
0.74	158.17 ± 4.16	159.22 ± 7.06	159.24 ± 7.26	159.66 ± 4.20	Height (cm)
0.51	88.55 ± 10.7	86.35 ± 11.33	87.35 ± 11.33	87.42 ± 4.61	Weight (kg)
0.17	35.88 ± 4.23	34.33 ± 1.84	34.23 ± 1.44	33.69 ± 2.64	Body composition index (kg/m2)
0.61	26.76 ± 1.8	26.78 ± 4.32	26.73 ± 4.07	27.66 ± 3.45	Maximum oxygen Consumption (ml/kg/minute)

* The significance level was P [P ≤ 0.05] and the Kolmogorov–Smirnov test was used for the normality of the subjects' characteristics.

Table 2. Specifications of the training protocol

Duration of training (Minutes)	Speed (Km/hour)	Slope (%)	Level
5	1.7	0 %	Heat
3	2.7	10 %	First
2	4.8	10 %	Second
2	6.4	10 %	Third
3	8	10 %	Fourth
2	9.7	15 %	Fifth
2	11.3	15 %	Six
2	12/8	15 %	Seventh
5	2.5	0 %	Cool

2.2. Blood sampling and its analysis

Blood was taken from the subjects in two stages before physical activity and immediately after physical activity and 5 cc was taken from the arm vein in each stage. Blood samples were prepared after fasting for 8 hours in the pre-test and post-test, and after collection in the laboratory, they were centrifuged at 3500 rpm. Until the work was done, the samples were kept at -20 degrees Celsius. In this study, hs-CRP levels were measured using the Biomerica commercial kit made in Germany using the ELISA method, and the CK enzyme was also measured with the help of the Pars Azmoun kit and by a spectrophotometer.

2.3. Statistical method

Descriptive statistics were used to calculate the mean and the Kolmogorov Smirnov test was used to determine the normal distribution of the

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data. The dependent t-test was used to compare the changes in the variables before and after the exercise, as well as the analysis of covariance test was used to check the changes between the exercises. All calculations were analyzed using SPSS version 23 software and the significance level of the tests was considered P<0.05.

3. Results

The mean and standard deviation of the anthropometric indices, body composition, and heart rate of the studied subjects are shown in Table 3. The results of statistical tests related to hs-CRP and creatine kinase are given in Table 3. The results of statistical tests related to hs-CRP and creatine kinase are given in Table 2. According to the results of statistical tests on hs-CRP and CK in pre-test and post-test showed that the amount of these indicators in four groups has increased significantly (P < 0.05). Also, the statistical results of one-way variance showed that four weeks of *ginger* supplementation following one session of external and concentric activities had a significant effect on hs-CRP levels of the four supplemental and placebo groups (P < 0.05). In addition, four weeks of *ginger* supplementation following one session of external and concentric activities had no significant effect on the CK levels of the four supplemental and placebo groups (P = 0.05).

Table 3. Comparison of changes in hs-CRP and CK indices

P (between Group)	P (within group)*	Post-test	Pre-test	Group	Indicator
0.06	0.02	1.58 ± 0.24	1.27 ± 0.99	Supplement + Eccentric training	Hs-CRP
	0.05	1.80 ± 0.31	1.16 ± 1.45	Supplement + Concentric Exercise	
	0.02	1.60 ± 0.41	1.27 ± 0.37	Placebo + Eccentric exercise	
	0.01	1.86 ± 0.36	1.16 ± 1.83	Placebo + Concentric exercise	
	0.1	1.44 ± 0.53	1.43 ± 0.72	Control	
0.09	0.01	75.22 ± 4.21	73.74 ± 5.57	Supplement + Eccentric training	CK
	0.03	75.22 ± 4.21	73.74 ± 5.57	Supplement + Concentric Exercise	
	0.04	89.72 ± 7.57	75.19 ± 5.09	Placebo + Eccentric exercise	
	0.01	89.72 ± 7.57	75.19 ± 5.09	Placebo + Concentric exercise	
	0.2	82.08 ± 5.08	70.17 ± 7.91	Control	

*The level of significance was (P ≤ 0.05) and the correlated T-test was used to examine intra-group changes and the analysis of covariance test was used to compare between groups

4. Discussion

The results of the present study indicate that 4 weeks of *ginger* supplementation caused a significant increase in CK, and hs-CRP values after acute eccentric and concentric activity in the supplement groups, but this increase is less than in the placebo groups. The results obtained in line with the research of Ajam et al. [2016] showed that performing acute extroverted and introverted activities increases inflammatory indices and muscle damage after the activity [27]. One of the reasons for alignment is the type and duration of training. These results were in line with the findings of Black et al. [2008] and Clarkson et al. (2006) [28, 29]. Clarkson et al. showed that eccentric contraction on the elbow flexor muscle caused an increase in CK enzyme after activity [28]. The results of the current research are in line with the findings of Black et al., who have shown that running on a treadmill with 60 and 85 % of the maximum oxygen consumption increases inflammatory

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indices after exercise [29]. Some researchers, including Gaini et al. [2010], talk about the non-increase of inflammatory indices after strenuous exercise, which is inconsistent with the present study. The reason for this result was stated that the inflammatory response to resistance exercise depends on the intensity and duration of exercise, glycogen content and the internal mechanism of muscles, etc. [30]. In another study conducted by Vahdatpour et al. [2016], he investigated the effect of acute extrovert activity on serum hs-CRP and creatine kinase during two stages in response to extrovert activity. The results of this research showed that outdoor exercise significantly increases the levels of hs-CRP and CK after exercise, and taking *ginger* supplements for two weeks did not have a significant effect on the levels of hs-CRP and CK[31]. One of the reasons for the disparity between the mentioned research and the current research is the type of subject. The research results were consistent with the findings of Matsumura et al. [2015] and Padrvnd et al. [2013] [32, 33]. Matsumura et al investigated the effect of *ginger* supplementation on delayed muscle injury and contusion in men, following heavy resistance training, and concluded that consuming 4 grams of *ginger* for 5 days had no significant effect on muscle injury and contusion [32]. In this regard, Padrvnd et al., in a study conducted on 22 non-athlete men along with a progressive endurance training program, reached these results, that the consumption of *ginger* supplement for 6 weeks did not have a significant effect on the reduction of creatine kinase enzyme, which may be due to the dosage and the length of the supplementation period [33]. The time of taking ginger supplements is one of the very important points that should be taken into consideration. In a study, Daryanosh et al observed that the most effective *ginger* supplement for reducing muscle damage is when it is consumed one hour before physical activity. The non-alignment of this result with the present findings may be due to the timing of supplement use. Considering that in the present study, the *ginger* supplement was used one day before physical activity [34]. One of the reasons that can be stated for the non-significance of the current research is the duration and dose of the *ginger* supplement as well as the type of subjects. In this regard, Karimi et al. [2015] concluded that 4 weeks of aerobic exercise in water Along with taking a *ginger* supplement [4 capsules containing 750 mg of *ginger* powder daily] in obese women with cancer, hs-CRP levels decreased [35]. Black et al. [2010] reported in another study, that acute use of *ginger* supplements after outdoor activity does not have a significant effect on reducing pain and inflammation. Among the reasons for the non-significance, was the duration of acute *ginger* consumption and also the type, quantity, and quality of the *ginger* compounds used, including gingerol-6 [13]. So it can be concluded that one of the reasons for the non-significance of hs-CRP in the current study is the type and amount of *ginger* compounds used. Bratpour et al. [2013] conducted a study on the inflammatory indices of 20 male volleyball players, who were divided into two groups of 10. The Oxford method training group [heavy to light] with and without *ginger* supplement, which was performed with an interval of one week; and the placebo group that only experienced weight training in the Oxford method. The supplement group consumed 3 grams of *ginger* daily [1 gram per meal] for one week. The results showed: that the consumption of *ginger* supplements reduced the inflammatory indices immediately after exercise [36]. The amount of the daily dose of the

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supplement and the type of test [athlete] can be one of the reasons for the discrepancy between this research and the current research. Also, Christopher et al. [2010] investigated the effect of consuming 2 grams of *ginger* on 27 participants after extrovert training. They concluded that *ginger* supplement reduces muscle damage and inflammatory indicators after extrinsic exercise [37].

Many studies regarding the use of *ginger* supplement with acute eccentric and concentric activity on hs-CRP and creatine kinase serum of obese girls have not been done, and according to the reports of previous studies based on the use of *ginger* supplement with acute eccentric and concentric activity on hs-CRP and creatine kinase. The head of fat girls.

5. Conclusion

The result of the present research indicates that 4 weeks of *ginger* supplementation increased the values of CK and hs-CRP after acute extroverted and introverted activity, and this increase is less compared to the placebo group. Considering that taking *ginger* supplements reduces inflammatory factors in obese people, it is recommended to conduct a similar study with higher doses or longer duration of *ginger* in overweight people to clarify the dimensions of this issue.

Author contributions

Conceptualization: A.S., M.F.; Research and sampling method: A.S.; Data analysis: A.S.; Text writing and revision: A.S., M.B.

Conflict of interest

The authors of the article do not declare any conflict of interest.

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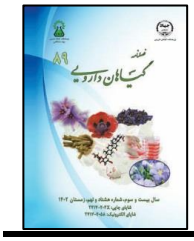

مقاله تحقیقاتی

تأثیر مصرف مکمل زنجبیل همراه بر شاخص‌های التهابی و آسیب عضلانی در سرم پس از فعالیت برونگرا و درونگرا دختران چاق

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اطلاعات مقاله

گل‌واژگان:
زنجبیل
کراتین کیناز
hs-CRP
فعالیت درونگرا و برونگرا

چکیده

مقدمه: برخی از فعالیت‌ها همانند فعالیت حاد می‌توانند سبب افزایش شاخص‌های التهابی و آسیب عضلانی در خون شوند. **هدف:** هدف از تاثیر مصرف مکمل زنجبیل همراه فعالیت حاد برونگرا و درونگرا بر برخی شاخص های التهابی و آسیب عضلانی سرم دختران چاق بود. **روش بررسی:** بعد از اندازه‌گیری حداکثر اکسیژن مصرفی تعداد ۵۰ دختر با نمایه توده بدنی بالای۳۰ کیلوگرم برمترمربع، سن ۷/۷۳ ± ۲۴/۸۹ سال، قد ۵/۲۰ ± ۱۵۹/۰۲ سانتی‌متر و وزن ۸/۸۸ ± ۸۷/۷۷ کیلوگرم به طور تصادفی به ۵ گروه شامل: گروه تجربی ۱ (مکمل+برونگرا) (۱۰ = n)، گروه تجربی۲ (مکمل+درونگرا) (۱۰ = n)،گروه دارونما+برونگرا (۱۰ = n)، گروه دارونما+درونگرا (۱۰ = n) و گروه کنترل (۱۰ = n) تقسیم شدند. پروتکل تمرینی شامل فعالیت حاد برونگرا و درونگرا (شیب مثبت و منفی بر روی تردمیل) اجرا شد. گروه‌های مکمل روزانه ۲ گرم پودر زنجبیل را، به مدت ۴ هفته مصرف می‌کردند. پس از حداقل ۸ ساعت ناشتایی نمونه‌های خونی قبل و بلافاصله پس از هرنوع فعالیت برای اندازه‌گیری سطوح hs-CRP و CK سرم جمع‌آوری شد .برای بررسی تغییرات درون گروهی از t وابسته و برای مقایسه بین گروهی از تحلیل کواریانس با عامل بین گروهی استفاده شد (P = ۰/۰۵). **نتایج:** نتایج t وابسته این پژوهش نشان داد تمرین حاد برونگرا و درونگرا در پیش آزمون، پس آزمون به ترتیب سبب افزایش معنادار سطوح hs-CRP و CK در گروهای مکمل و دارونما می‌شود (P ≤ ۰/۰۵). همچنین نتایج تحلیل کوواریانس نشان داد مصرف چهار هفته مکمل زنجبیل بدنبال فعالیت حاد برونگرا و درونگرا بر سطوح hs-CRP (P = ۰/۰۴) بین گروه‌های مکمل و دارونما تأثیر معنی‌داری را نشان داد. علاوه برآن مصرف ۴ هفته مکمل زنجبیل بدنبال فعالیت حاد برونگرا و درونگرا بر سطوح CK (P = ۰/۰۹) بین گروه‌های مکمل و دارونما تأثیر معنی‌داری نداشت. **نتیجه‌گیری:** افزایش سطوح التهاب و آسیب عضلانی در تمرین حاد درونگرا بیشتر از برونگرا می‌شود. با توجه به نتایج حاصل از این پژوهش، مصرف روزانه مکمل زنجبیل می‌تواند التهاب و آسیب عضلانی ناشی از فعالیت بدنی را کاهش دهد.

مخففها: Hrmax، ضربان قلب؛ BMI، **شاخص ترکیب بدن**

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