

Research Article

The Effect of One Session of the Exhaustive Exercise & Caffeine Consumption on Muscle Fatigue Levels & Anaerobic Power of the Professional Female Karatekas

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Abstract

Background: The results of some research studies have revealed the positive effect of the caffeine consumption on the muscle fatigue and anaerobic power of the athletes. According to these findings, the purpose of the present research study is investigating the effect of one session of exhaustive exercise and caffeine consumption on muscle fatigue levels and anaerobic power of the professional female karatekas.

Materials and Methods: In this experimental study, 30 professional female karatekas who had at least been present in the Karate national team selected camp once, were chosen based on the entrance criteria and the purposive sampling. The samples were randomly divided into three homogeneous groups consisting of 10 individuals (two groups receiving the 6 and 9 milligrams of caffeine supplement for each kilogram of body weight) and the placebo (6 milligrams of dextrose for each kilogram of body weight). The blood samples were taken prior to and after the anaerobic exhaustive test of Cunningham and Faulkner. The data were analyzed using analysis of covariance (ANCOVA).

Results: The results of the study revealed that there was a significant difference between the control and 9-miligram caffeine groups in all variables ($P < 0.005$). Finally, the results of the study demonstrated that there was a significant difference resulting from the effect of 6 and 9-milligrams caffeine amounts on the levels of lactate, lactate dehydrogenase, creatine kinase, peak, average, anaerobic power and fatigue of the professional female karatekas ($P < 0.005$), though, there was no significant difference among the lactic acid, PH and the anaerobic power drop ($P \times 0.005$).

Conclusion: According to the results of the study, it is recommended that female karatekas use the 9-miligram dosage caffeine supplement for reducing the levels of muscle fatigue and increasing the anaerobic power and blood PH.

Keywords: Exhaustive Exercise, Caffeine, Muscle Fatigue, Anaerobic Power, Professional Female Karatekas.

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1. Introduction

In recent years, the researchers have tried to improve the physical function in various ways. Fatigue is one of the most significant factors in the inability of the person to show better performance, especially in short-term and high intensity periods. Postponing and avoiding the fatigue is possibly one of the most important objectives of the athletes in different fields (1). Adaptation to the severe and exhaustive exercises is intricate and various (2). Reaching the peak of the athletic performance, is the main goal of coaches and athletes. The nutrition is considered a noteworthy factor for attaining this goal. One of the nutritional aspects that is widely regarded in the sports world, is using the nutritional supplements for improving the athletic performance (3). Caffeine is one of the sports supplements which is highly consumed by the endurance, strength, and velocity athletes (3,4). Caffeine is a pseudo-crystal substance, in white color, having a bitter taste, under the title of (1, 3, 7-trimethylxanthine) and with the chemical formula of $C_8H_{10}N_4O_2$ which is fat soluble and is quickly absorbed by digestive system. It seems that the metabolism and analysis of caffeine in people are influenced by the individual genetic differences. In addition, caffeine is considered a natural stimulant which exists in more than sixty plants, though it is mainly obtained from a plant named "Coffea Arabica" and is chiefly found in tea, coffee, Nescafe, Coca-Cola beverages, and chocolates containing cocoa (5). This substance has been quite popular among the athletes in various sports fields and even in ordinary people for increasing the awareness and concentration power, improving the decision making, as well as the mental and physical functions (6).

As an energizing factor, caffeine would cause the increment of force production of the muscles at the time of the skeletal muscle contraction by affecting the release of Catecholamine and boosting the calcium release from the sarcoplasmic reticulum, and is suggested for improving the performance of the athletes in sports activities (7). Countless research studies have reported the positive effects of caffeine on improving the capability and power required for executing the sports skills (8). The results of some existing researches reveal that consuming the caffeine compounds can reduce the occurrence of metabolic pressure and inflammatory responses by applying the method of avoiding the activity of phosphodiesterase nucleotide cycles enzymes, increasing the cyclic adenosine monophosphate, opposition to adenosine receptors, and cleansing the free foundations and modulation of gene expression (9,10). The results of some studies depicted that consuming 6 milligrams of caffeine for each kilogram of body weight, has no significant effect on the anaerobic function of the participants (11). Additionally, the findings of another study revealed that consuming caffeine (4.5 milligrams per kilogram of bodyweight), would not prevent from the 24-hour displeasing increase in the indexes relating the muscle injuries resulting from the performance of one strength activity session (12).

In the sports fields such as karate, the metabolic changes in active muscle groups are considered as the factor restricting the maximum athletic activities and the occurrence of fatigue. In strenuous exercises, the density of hydrogen and lactate ions in muscles and blood increases which will lead to the muscle fatigue by the reduction of PH and acidification of the intramuscular environment (13). Thus, it is quite important that the muscles in action postpone the reduction of PH and accumulation of lactate. The decrease of lactate accumulation has so many positive effects on the body cells of the athletes and would cause the delaying of the fatigue (14). Nowadays, any factor capable of reducing the fatigue index or increasing the anaerobic power, is important concerning the ergogenic aspect and could be influential in creating the appropriate background for applying the maximum pressure (15). Caffeine exercises its ergogenic effects by reducing the reaction time, delaying the fatigue, increasing the concentration and awareness, boosting the elicitation of the fatty acids, increasing the calcium release from the sarcoplasmic reticulum, improving the contractility of the skeletal muscle, enhancing the secretion of Catecholamines, raising the power production by boosting the neurotransmission and improving the production of maximum activity of the muscle. On the other hand, to improve the power, endurance and muscle strength, the athletes seek to utilize the supplements that are firstly, authorized and secondly, include less side effects. Therefore, in case the ergogenic effects of caffeine are proved, it could be recommended to these athletes so that they can safely apply it prior to their exercise or competition.

According to this issue, this theory regarding the caffeine consumption having more ergogenic effects on the athletes, is being accepted (16). Based on the contradictory results of the limited studies obtained from the investigation of 6-miligram and less dosages of caffeine, as well as lacking the access to the comprehensive and collected researches, the following question is raised: does one exhaustive exercise and caffeine consumption have the capability required for the reduction of the muscle fatigue and anaerobic power indexes?, or by interacting with the exhaustive exercise, does it have a double effect on the unpleasant levels of muscle fatigue and anaerobic power indexes? Thus, the present research study aims at investigating the effect of one session of the exhaustive exercise and the caffeine consumption (6 and 9 milligrams for per kilogram of body weight) on the muscle fatigue and anaerobic power levels of the profession female karatekas.

2. Materials and Methods

Subjects

According to the statistical samples, variables and research goals, the present research study is considered of semi-experimental type. From among the statistical society and based on the entrance criteria (such as having no cardiorespiratory disease, non-usage of tobacco, drugs and medicine, no serious musculoskeletal injuries, having no prohibition for performing the exercises and no allergy to caffeine consumption as well as no record of keratin consumption as a daily habit) 30 professional female karatekas were elected as the participants. According to the fatigue index obtained from RAST pretest, the mentioned participants were randomly elected in three homogeneous groups of 10 members (two groups as the receivers of 6 and 9 milligrams caffeine supplements for per kilogram of body weight) and the placebo group (6 milligrams dextrose for per kilogram of body weight). Prior to the commencement of the research, some sessions are considered for familiarization with the research stages, research methods and the duration. Additionally, after the agreement of the individuals and filling the consent letter form for taking part in the research, their anthropometric and physical features such as the age, weight and height were measured and they were requested to refrain from performing severe exercises, and consuming special diet, caffeine and keratin during the execution of the study. The participants are demanded to avoid doing sever physical exercises 24 hours before the test and refrain from eating and drinking caffeine in any form 48 hours before the commencement of the test (the substances containing caffeine were presented to the participants in a list).

Furthermore, the participants were asked to avoid using any kind of supplement for two weeks prior to the test. Additionally, the required coordination was provided regarding the commencement of the supplementation period and performance of the respective protocol (the tests are performed in the follicle phase of the menstruation cycle (day 1-14)) to avoid the possible effects of the menstruation cycle. The protocols were RAST test and Cunningham and Faulkner anaerobic exhaustive test.

RAST Test

In RAST test, by hearing the "go" command, the participants respectively run a 35-meter distance in the maximum speed. We calculated the weight of each individual before the test. Two referees and two chronometers were at hand. One of the referees recorded the 35-meter duration and the other recorded 10-seconds duration of the recovery. After running the 35-meter distance, each participant rested for 10 seconds and immediately after finishing the 10 seconds, they ran the 35-meter distance afresh in their maximum speed. This phase was repeated for three times. In other words, each participant ran the respective distance round trip for six times. The obtained records were registered in all six turns. The peak of power, minimum power, average power and the fatigue index were calculated based on the instruction of the test.

Cunningham and Faulkner Anaerobic Exhaustive Test

Cunningham and Faulkner anaerobic exhaustive test was performed after 45 minutes as follows (17):

1. 10 minutes of warm up exercises including the stretches movements.
2. Setting the treadmill incline to 20 degree.
3. Speed of 12.9 kilometers per hour.
4. performing the exercise until reaching the exhaustion (when the individual is not able to continue anymore).
5. Registering the time period of the activity.

Blood Sampling

The blood samples were prepared in two phases (the first phase was performed before consuming the supplement and placebo; and the second phase was performed 5 minutes after the execution of anaerobic exhaustive test of Cunningham and Faulkner). Before the consumption of the supplement and placebo, the samples were asked to go fasting for 8 to 10 hours. 50 minutes prior to receiving the capsule, the 9 CC blood sample were taken from the brachial vein for investigating the serum levels of lactate, lactic acid, PH, creatine kinase, and lactate dehydrogenase, and the obtained amounts were registered as the pretest. After ten minutes of doing the stretch and warm up exercises, the participants performed the protocol of the exhaustive exercise. Immediately after completing the protocol of the exhaustive exercise, the blood sampling was performed for the second time to examine the changes, and the gained amounts were registered as the posttest.

For being centrifuged regarding the obtainment of serum and plasma, the blood samples were promptly poured into the test tubes and after being coded, they were immediately transferred to the laboratory and were preserved in special refrigerators at -70 Degrees Celsius up to the performance of the blood analysis. Eventually, the obtained blood samples were analyzed by means of specific kits to measure the levels of lactate, lactic acid, PH, creatine kinase, and lactate dehydrogenase. Similar to the pretest, the levels of lactate, lactic acid, PH, creatine kinase, and lactate dehydrogenase were assessed for the second time immediately after performing the exercise protocol of all three groups in the posttest as well. The mentioned variables in the blood serum were analyzed at the laboratory.

Double-Blind Method

Based on a table, each participant was informed about the days on which they should consume the caffeine or placebo, prior to the test. The consumption order of the caffeine or placebo were randomly determined in this table. The researcher and the participants were not aware of the table's contents up to the completion of the measurements. On the test day and 45 minutes after taking the caffeine and placebo, the participants performed the warm up exercises for 10 minutes. Then, anaerobic exhaustive test of Cunningham and Faulkner was taken. In addition, after 48 hours, RAST test was taken from the participants based on the protocol.

Statistical analysis

For describing the statistical data of the research, the average, median, mode, minimum and maximum standard deviations were utilized. In the following, for determining the natural distribution of research data, the Shapiro–Wilk test was used. After confirming the assumption regarding the natural distribution of research data for all variables in pretest and posttest phases in different groups ($p \geq 0.05$), the Levene's test and the analysis of covariance were utilized for testing the research hypothesis. All statistical analysis was performed by means of SPSS23 software and at the significance level of $p < 0.05$.

3. Results

The results of the study demonstrated that the distribution of the pretest and posttest data were normal in the groups ($P > 0.5$), and the variance of the pretest and posttest data of the groups were equal. Additionally, the homogenous assumption of the regression slope was observed as well. According to the observation of the covariance test hypothesis, this test was used for investigating the grades' difference of the groups' posttest.

Table 1: The Test for Effectiveness of One Phase of the Exhaustive Exercise and Consumption of 6 & 9 Milligrams of Caffeine Supplements in the Levels of Lactate, Lactate Dehydrogenase, Lactic Acid, PH, Creatine Kinase in Professional Female Karatekas

Variable	Source	Total Type III Squares	Degrees of Freedom	Square Root of the Average	F	Significance Level	Coefficient of Eta Partial Square Roots
Lactate	6 Mg	869.741	1	869.741	30.919	0.001	0.645
	9 Mg	4064.623	1	4064.623	160.985	0.001	0.904
	6 & 9 Mg	1195.046	1	1195.046	115.711	0.001	0.872
Lactate Dehydrogenase	6 Mg	18.063	1	18.063	2.477	0.134	0.127
	9 Mg	347.750	1	347.750	63.681	0.001	0.789
	6 & 9 Mg	209.077	1	209.077	44.713	0.001	0.725
Lactic Acid	6 Mg	11.254	1	11.254	51.605	0.001	0.752
	9 Mg	15.501	1	15.501	82.898	0.001	0.830
	6 & 9 Mg	0.135	1	0.135	0.827	0.376	0.046
PH	6 Mg	0.001	1	0.001	0.160	0.694	0.009
	9 Mg	0.008	1	0.008	8.149	0.011	0.324
	6 & 9 Mg	0.005	1	0.005	4.218	0.056	0.199
Creatine Kinase	6 Mg	1700.125	1	1700.125	78.470	0.001	0.822
	9 Mg	3448.879	1	3448.879	235.759	0.001	0.933
	6 & 9 Mg	306.816	1	306.816	28.264	0.001	0.624

Table 2: The Test for Effectiveness of One Phase of the Exhaustive Exercise and Consumption of 6 & 9 Milligrams of Caffeine Supplements in Levels of Peak, Average, Minimum Power & Fatigue Index of Professional Female Karatekas

Variable	Source	Total Type III Squares	Degrees of Freedom	Square Root of the Average	F	Significance Level	Coefficient of Eta Partial Square Roots
Peak of Anaerobic Power	6 Mg	10842.372	1	10842.372	23.627	0.001	0.582
	9 Mg	42850.295	1	42850.295	77.632	0.001	0.820
	6 & 9 Mg	10337.434	1	10337.434	27.262	0.001	0.616
Average of Anaerobic Power	6 Mg	4672.996	1	4672.996	37.637	0.001	0.689
	9 Mg	9034.795	1	9034.795	79.599	0.001	0.824
	6 & 9 Mg	570.094	1	570.094	9.240	0.007	0.352
Minimum Power	6 Mg	3308.699	1	3308.699	17.179	0.001	0.503
	9 Mg	6687.533	1	6687.533	26.834	0.001	0.612
	6 & 9 Mg	470.426	1	470.426	26.834	0.158	0.114
Fatigue Index	6 Mg	0.013	1	0.013	3.720	0.071	0.180
	9 Mg	0.060	1	0.060	13.497	0.002	0.443
	6 & 9 Mg	0.015	1	0.015	10.478	0.005	0.381

According to the results, there was a significant difference among the control groups and 6 milligram caffeine groups regarding the levels of lactate, lactic acid, creatine kinase, peak of power, average of power and minimum power of the professional female karatekas ($P < 0.005$). This matter reveals that after excluding the effect of the pretest, one exhaustive exercise phase and consumption of 6 milligrams caffeine supplement, has had a significant effect on the levels of lactate, lactic acid, creatine kinase of athletes were presented in Table 1 and peak, average and minimum power of the professional female karatekas were presented in Table 2. though, there was no significant difference among the research groups concerning the levels of lactate dehydrogenase, PH and fatigue index of the professional female karatekas ($P > 0.005$). In addition, there was revealed a significant difference among the control groups and 9 milligrams caffeine groups concerning all variables in the professional female karatekas ($P < 0.005$). One phase of the exhaustive exercise and consumption of 9 milligrams of caffeine supplement, has had a significant effect on the levels of lactate, lactate dehydrogenase, lactic acid, PH, creatine kinase, peak, average and minimum of the anaerobic power and fatigue of the professional female karatekas.

Finally, the results showed that there was a significant difference between the effects of 6 and 9 milligrams of caffeine on the grade of lactate, lactate dehydrogenase, creatine kinase, peak, average, anaerobic power and fatigue of the professional female karatekas ($P < 0.005$), though there was no significant difference between the effects of 6 and 9 milligrams on lactic acid, PH and minimum power ($P > 0.005$). Coefficient of Eta partial square roots depict that in lactate index, 0.872 percent, lactate dehydrogenase 0.725 percent, creatine kinase 0.625 percent, peak of anaerobic power 61.6 percent, average of anaerobic power 35.2 percent and the fatigue index 38.1 percent of the variance of the dependent variable (posttest) are clarified by the independent variable. According to this issue, one phase of exhaustive exercise and consumption of 9 milligrams of caffeine consumption, is more effective on the levels of lactate, lactate dehydrogenase, creatine kinase, peak, average, anaerobic power and fatigue of the professional female karatekas, compared to the consumption of 6 milligrams caffeine.

4. Discussion

The purpose of this study was to investigate the effect of one session of the exhaustive exercise and caffeine consumption on the lactate, fatigue index and anaerobic power of the professional female karatekas. It has been revealed that caffeine supplement improves various aspects of the athletic performance and is utilized as a highly consumed ergogenic supplement in lots of the sports fields.

The analysis of the obtained results demonstrated that the caffeine consumption has a significant effect on the power peak, average of the anaerobic power and the fatigue. These findings are in line with the results of the research studies conducted by Bell (2001), Nazem & Collogues (2009), Vermeziar & Collogues (2013), Arazi & Dehlavinejad (2016), Doherty & Collogues (1998), Ranjbar & Collogues (2009), and Wiles & Collogues (2006), though they are not in line with the results of the studies conducted by Ranjbar & Collogues (2009), J. Hoffman & Collogues (2007), Lorino & Collogues (2006). In a research study conducted by Bell (2001), he reported that the caffeine consumption in super bicycle test (125 % peak of the anaerobic power), would increase the time to reach the exhaustion (18). Furthermore, in a study conducted by Doherty & Collogues (1998), they revealed that caffeine consumption in amount of 5 milligrams, would improve the performance in severe short-term running exercises, equivalent to 125% of the peak of the anaerobic power (19). Nazem & Collogues (2009), pointed to the issue that caffeine consumption in male football players, could increase the peak of the aerobic power.

This similarity may be due to the nature of some football exercises which are in a way alike the exhaustive exercises (20). Arazi & Dehlavinejad (2016), revealed that continuous supplementation of caffeine in female handball players would have a significant effect (on the maximum, minimum and average) (21). In addition, Vermeziar & Collogues (2013), investigated the effect of caffeine supplement consumption on the fatigue index and pressure in male aerobic and anaerobic athletes. The participants were initially examined by RAST test. Afterwards, they were given 4 milligrams of caffeine for per kilogram of body weight. The results depicted the effectiveness of caffeine in the amount of the aerobic power of the research participants (22). Additionally, the results of the study conducted by Mounex & Colleagues (2017), under the title of "Comparing the Effects of Severe Interval Exercises & Performance of the Athletes in the Field of Taekwondo" revealed that 11 sessions of performing severe interval exercises notably improved the anaerobic power of the university athletes in the field of Taekwondo (23). Thus, by comparing the research studies, it is observed that in most cases the effect of caffeine consumption during the performance of the exhaustive and severe exercises with their dominant energy source as ATP/PCr, are referred to. The recommended mechanisms for explaining the effects of caffeine on the increase of the minimum power and average by stimulating the central nervous system, can cause the accumulation of the circular AMP by the inhibition of phosphodiesterase and blocking the competitive adenosine receptors.

There is the possibility that caffeine affects the stimulations reaching the central nervous system from the environment, such as reducing the awareness of the emotions relating the muscle fatigue. Another possible justification for improving the minimum and average of the power may be due to the increase of Na-KATPase activity in the muscle tissue. Ranjbar & Colleagues (2009), revealed that caffeine consumption has no significant effect on the peak of the anaerobic power (24). In addition, J. Hoffman & Colleagues (2007), demonstrated that the coffee enriched with caffeine compared to the coffee lacking caffeine, had no effect on the peak of power and total activity in 30-second Wingate test (25). Furthermore, in a research study conducted by Lorino & Colleagues (2006), they concluded that consuming 6 milligrams of caffeine in young people having some exercises, had no significant effect on the power output when measured by the Wingate test (26). Maybe the reason for these conflicts are the sample of testing, the amount of physical readiness or utilizing the caffeine dosage less than 9 milligrams, though in the present research study, consuming the dosage of 9 milligrams have had more effect on the power peak of the professional female karatekas. Similar to the peak of the anaerobic power and average of the anaerobic power of professional female karatekas in one session of exhaustive exercise, the minimum of the anaerobic power was improved by the influence of caffeine. This matter reveals that caffeine supplementation could be applied for improving the performance of the athletes, specifically in severe exercises.

The analysis of the results of this study shows that caffeine consumption has significant effect on the levels of lactate, lactate dehydrogenase, and creatine kinase. Caffeine is known as an ergogenic assistant factor in the athletes. Caffeine affects the nervous, metabolic, hormonal, muscular and cardiovascular systems, and the levels of epinephrine and norepinephrine are increased after the consumption of caffeine which will result in the acceleration of the aerobic and anaerobic metabolism. Furthermore, ATP can be produced in the form of glycogen from the carbohydrates stored in the muscle at high speed, though this procedure would cause the production of lactic acid which its accumulation will lead to the muscle fatigue (7,8). It is possible that partial increase in the amount of the blood lactate resulting from the caffeine consumption, is due to the raising of catecholamines release. The ATP produced by lactic system could provide the severity of the exercise for 1-3 minutes. In severe exercise the density of hydrogen and lactate ions are increased in the muscles and the blood and the reduction of PH and acidization of the intermuscular environment, will lead to the muscle fatigue. Therefore, it is quite important that the working muscles postpone the decrease of PH and accumulation of lactate (27). High levels of lactic acid, increase the acidity of blood and tissues which will lead to fatigue and reduction of ATP production.

The results of this study are in line with findings of the research studies conducted by Ranjbar & Colleagues (2009), Hournie & Colleagues (2007), and Azizi Masouleh & Colleagues (2015), though, they are not in line with the results obtained from studies conducted Wimerkati & Colleagues (2008) and Jafari (2012).

Ranjbar & Colleagues (2009), investigated the effect of caffeine consumption on the fatigue index of blood in 24 male athlete students who had volunteered for performing the RAST test. The findings revealed that caffeine consumption has a positive effect on the fatigue index and caused the reduction of the fatigue index in the samples (24).

Hournie & colleagues (2007) investigated the effect of caffeine (3 milligrams per kilogram) on 12 male and professional lawn tennis players and reported that the caffeine consumption increased the serve speed in the last competition set compared to the placebo group. In addition, they claimed that the caffeine consumption reduced the effects caused by fatigue during the competition (28).

Azizi Masouleh & Colleagues (2015) revealed that there was no significant difference in various levels of caffeine supplement consumption among the amounts of lactic acid accumulation and accordingly, the reduction of PH levels at the 10th minutes of returning to the initial phase. Though, there was a significant difference between the accumulation of lactic acid in the 1st minute of returning to the initial phase in various levels of caffeine consumption (29). Machado & Colleagues (2010) ³, investigated the effects of acute caffeine consumption (4 milligrams for per kilogram of body weight) in 15 male and elite football players by performing one session of circular strength exercises (three shifts with 10 maximum repetitions). The researchers mentioned that the acute caffeine consumption could not prevent the significant increase in creatine kinase and lactate dehydrogenase enzymes (30).

In addition, by investigating two different amounts of caffeine (4.5 and 5.5 milligrams per body weight), Wimerkati & Colleagues (2008) declared that the acute caffeine consumption in different amounts, was not capable of adjusting the unpleasant indexes of cell damage after performing 60 minutes of aerobic exercise, with intensity of 65% of maximum oxygen consumption (31). The results of these researches concerning the incapability of caffeine in reducing the biochemical indexes immediately after the activity, occurred while the ranges of changes in all indexes relating the muscle damage of the subject of the present study were significantly more than the placebo group. On the other hand, the findings of the research study conducted by Jafari (2012) are in contrast with the results of the present study, revealing that the long-term consumption of caffeine would cause the significant reduction of the muscle damage (Creatine Kinase). They declared that caffeine consumption shall lead to the significant reduction of the total serum creatine kinase 24 hours after the exercise (32). Additionally, the evidence of a research demonstrated that caffeine consumption would cause the increase of calcium ion, that would possibly lead to the enhancement of the anaerobic power. Though, the existing scientific evidence does not depict a clear mechanism regarding the manner which caffeine affect the release of calcium. Furthermore, it is recommended that the prescription of caffeine dosages is performed based on the tolerance level of the individual and the nature of the athletic field (9).

The existing contrasts in the present study and the results of the mentioned research project may be due to the difference in the method of supplementation (type of supplement, agreement for supplement consumption, amount and time of consumption), and athletic agreement (intensity, duration and type of activity).

The findings of the current research studies revealed that the adjusting effects of the caffeine on the symptoms and delayed indexes of muscle contusion, may be dependent upon the influence of caffeine consumption amounts. For instance, Chawz & Colleagues (2010), examined the effects of various amounts of caffeine (10, 20, and 50 Micromole in liter) and reported that only the plasma levels of 50 micromole per liter of caffeine (approximately equaling to the consumption of more than 6 milligrams of caffeine for per kilogram of body weight) could prevent from the increase of the tumor necrosis factor alpha in the central monocytes of blood (33). Basini & the Colleagues (2007) mentioned that the acute consumption of caffeine (5 milligrams for per kilogram of body weight) following the performance of 45 minutes of the simulated football game, would not be capable of decreasing the unpleasant effects of the physical activity on the muscle damages indexes (such as creatine kinase, lactate dehydrogenase and Leukocytosis) of the male football players (34). The review articles demonstrated the improvement of performance in consumption dosages ranging from 6 to 9 milligrams. At the present time, it has been identified that by direct effect on central nervous system, other than improving the awareness, caffeine is capable of decreasing the reaction time as well as the reduction of the perceived pressure (3).

Δ. Conclusion

Therefore, it is concluded that caffeine consumption in various dosages together with performing the exhaustive exercises, would have a significant effect on decreasing the muscle fatigue of the athletes. In brief, the results revealed that there was a significant difference among the control groups and 9 milligrams caffeine group regarding all of the variables. In addition, there is a significant difference among the 6 and 9 milligrams of caffeine concerning the levels of lactate, lactate dehydrogenase, creatine kinase, peak, average, anaerobic power and fatigue, though, there was no significant difference regarding the lactic acid, PH and minimum of the anaerobic power. In general, according to the results of the present research study, it is recommended that female karatekas use the caffeine supplement in 9 milligrams dosages, one hour prior to the athletic activity for improving their performance as well as decreasing the levels of lactate, lactic acid, lactate dehydrogenase, creatine kinase and muscle fatigue, and increasing the anaerobic power and blood PH.

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Compliance with ethical standards

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Author contributions

Conceptualization: R.B., S.G.H.; Methodology: R.B., S.G.H.; Software: R.B., S.G.H., K.M.S.; Validation: R.B., K.M.S.; Formal analysis: R.B., K.M.S., S.G.H.; Investigation: S.G.H., R.B., K.M.S.; Resources: R.B.; Data curation: R.B., S.G.H.; Writing - original draft: R.B., S.G.H.; Writing - review & editing: R.B., K.M.S., S.G.H.; Visualization: S.G.H.; Supervision: R.B.; Project administration: R.B.; Funding acquisition: R.B., S.G.H.

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