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The acute effect of l-arginine and vitamin c intake on aerobic-anaerobic performance, lactic acid, and blood glucose parameters in basketball players

Gülşen KARATAY[1], Gürhan SUNA[2], Emrah YILMAZ[2]

[1]Süleyman Demirel University, Institute of Health Sciences, Isparta, Turkiye
[2]Süleyman Demirel University, Faculty of Sport Sciences, Isparta, Turkiye

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Abstract

The aim of this study was to investigate of the acute effect of L-Arginine and Vitamin C intake on aerobic-anaerobic performance, lactic acid, and blood glucose parameters in basketball players. The study included 18 licensed basketball players. The basketball players were divided into three group: the placebo group, the L-Arginine and the L-Arginine+Vitamin C. The Conconi treadmill, Monark bicycle ergometer, lactate scout, and OKmeter Optima blood glucose measurement device were used in the research. The groups underwent aerobic Conconi treadmill test and Wingate anaerobic power test without any supplementation, and measurements of lactate levels, blood glucose levels, and aerobic-anaerobic performance were recorded. After a 48-hour washout period, each groups was supplemented, and the tests were repeated. To assess the pre- and post-test values within each group, a paired t-test was utilized. For comparisons between groups, One-Way ANOVA tests were conducted. Upon analyzing the results, statistically significant disparities were observed in peak power, running distance, and lactate levels between the pre- and post-tests in the L-Arginine+Vitamin C group ($p<0.05$). In conclusion, it has been demonstrated that the consumption of L-Arginine+Vitamin C enhances acute aerobic-anaerobic performance and reduces the accumulation of lactic acid in basketball players.

Keywords: Aerobic, anaerobic, basketball, vitamin c, l-arginine, performance

Basketbolcularda l-arginin ve c vitamini alımının aerobik-anaerobik performans, laktik asit ve kan glukozu parametreleri üzerine akut etkisi

Öz

Bu çalışmanın amacı basketbolcularda L-Arginin ve C Vitamini alımının aerobik-anaerobik performans, laktik asit ve kan glukozu parametreleri üzerindeki akut etkisini araştırmaktır. Çalışmaya 18 lisanslı basketbol oyuncusu dahil edilmiştir. Basketbolcular plasebo grubu, L-Arginin grubu ve L-Arginin+C Vitamini grubu olmak üzere üç kategoriye ayrılmıştır. Araştırmada Conconi koşu bandı, Monark bisiklet ergometresi, laktat cihazı ve OKmeter Optima kan şekeri ölçüm cihazı kullanılmıştır. Gruplara herhangi bir takviye yapılmadan aerobik Conconi koşu bandı testi ve Wingate anaerobik güç testi uygulanmış ve laktat seviyeleri, kan glikoz seviyeleri ve aerobik-anaerobik performans ölçümleri kaydedilmiştir. 48 saatlik bir arınma döneminden sonra, her bir gruba takviye yapılmış ve testler tekrarlanmıştır. Her bir gruptaki test öncesi ve sonrası değerleri değerlendirmek için eşleştirilmiş t-testi kullanılmıştır. Gruplar arası karşılaştırmalar için Tek Yönlü ANOVA testleri yapılmıştır. Sonuçlar analiz edildiğinde, L-Arginin+C Vitamini grubunda ön ve son testler arasında pik güç, koşu mesafesi ve laktat seviyelerinde istatistiksel olarak anlamlı farklılıklar gözlenmiştir ($p<0.05$). Sonuç olarak, L-Arginin+C Vitamini tüketiminin basketbolcularda akut aerobik-anaerobik performansı artırdığı ve laktik asit birikimini azalttığı gösterilmiştir.

Anahtar Kelimeler: *Aerobik, anaerobik, basketbol, vitamin c, l-arginine, performans*

This study was produced from a postgraduate thesis prepared at Süleyman Demirel University, Institute of Health Sciences, Department of Exercise and Sport Sciences.

Sorumlu Yazar/ Corresponded Author: Gürhan SUNA **E-posta/ e-mail:** gurhansuna@sdu.edu.tr

INTRODUCTION

Basketball is a team sport played with five players from two opposing teams, each team can have a maximum of seven substitutes, and the goal is to score in the basket of the opposing team, played according to certain rules (Darendelioğlu, 2008; Korkmaz, 2021). In team sports such as basketball, anaerobic performance comes to the forefront due to the need for high-intensity power generation in fast offense or pressurized defenses (Polat & Çetin, 2018). Basketball is a branch in which aerobic and anaerobic metabolisms are used intensively. However, in basketball, aerobic performance is also required to endure long-term low-intensity training and to perform in competitions lasting at least 40 minutes. Therefore, athletes are expected to have a high level of health and performance. In order for the performance to reach the desired level, factors such as the athlete's nutrition, physical fitness, and correct training come to the fore. In this context, both aerobic capacity and anaerobic capacity affect game performance (De Araujo et al., 2014; Sánchez-Díaz et al., 2020).

Sport performance is greatly influenced by health status, genetic predisposition, diet, training status, environmental factors, physiological, and psychological factors. It is difficult to determine which factor is more effective in an athlete's good performance. Although these factors vary according to various sports branches, proper and balanced nutrition is necessary for all sports branches to achieve good performance (Ersoy, 1996; Akkaya et al., 2019; Yarar et al., 2011).

A properly planned nutrition program for athletes not only positively affects the performance of the athlete but also reduces the risk of injury that may occur during training and competition and accelerates recovery (Ersoy, 2010). As there are energy systems, nutrients, and energy needs that differ according to sports branches, the nutritional needs of athletes in the same sports branch or in the same team may also be different. Therefore, athlete nutrition should be branch and individual-specific. The aim of nutrition in basketball is to ensure the development of conditional characteristics such as speed, agility, and strength (Acar et al., 2021; Öcal, 2021). Since basketball players have high muscle mass, their energy requirements are also quite high. However, large volumes of high-energy foods can cause gastrointestinal problems. Therefore, they benefit from ergogenic supplements to supplement the energy they need and keep their performance at the highest level (Escribano-Ott et al., 2022). Athletes use nutritional supplements for many reasons such as the desire to protect their health, prepare for exercise, increase the efficiency of exercise and accelerate recovery after exercise (Kerksick et al., 2018).

Vitamins and amino acids are the most preferred nutritional supplements by athletes. Due to its potential effects, L-Arginine is one of the most important and frequently used amino acids (Atabek & Özdemir, 2010; Gençoğlu et al., 2021; Yılmaz, 2016). Under normal conditions, it is synthesized from L-citrulline within the cell and is taken at 3-3.5 grams daily in the diet, reaching a maximum level in plasma 1-2 hours after oral intake (Yılmaz & Türker, 2015; Viribay et al., 2020). L-Arginine has effects on physiological and metabolic pathways that can improve athlete performance in both aerobic and anaerobic metabolism (Birol et al., 2019). While it stimulates nitric oxide and growth hormone secretion and contributes to increasing muscle mass and hypertrophy, it is known to be used by athletes due to its positive effects such as increasing tolerance to high-intensity exercise, providing blood flow to the muscles, removing ammonia and lactic acid accumulated in the blood after exercise, and accelerating recovery (Birol et al., 2019; Gambardella et al., 2021; Xu et al., 2010). In studies, the safe intake dose of L-Arginine supplementation has been determined as 1-15 g/day. It has been reported that consuming 9 g/day of L-Arginine does not have side effects, and side effects such as gastrointestinal system disorders, arrhythmia, and hypotension can be seen when consuming 9-30 g/day (Bayram & Öztürkcan, 2020; Yılmaz & Türker, 2015).

Due to its antioxidant effect, vitamin C is an essential vitamin widely used among athletes. It cannot be synthesized in the body and must be obtained from external sources through food. Vitamin C has positive effects on metabolism, such as strengthening the immune system, cartilage and bone development, collagen synthesis, stimulating nitric oxide synthesis, secretion of some hormones, and increasing iron absorption (Akkaya, 2020; Atabek & Özdemir, 2010; Gürsoy & Dane, 2002; Shaw et al., 2017). Additionally, it helps to reduce oxidative stress that occurs during exercise and plays a role in protecting cellular organelles from oxidative damage. It can accelerate recovery after exercise, reduce muscle damage, improve performance, and contribute to the functioning of blood glucose metabolism (Gęgotek & Skrzydlewska, 2022; Kerksick et al., 2018).

In light of the information obtained from the literature, the aim of this study was to investigate the acute effects of L-Arginine and vitamin C intake on aerobic-anaerobic performance, lactic acid, and blood glucose parameters in basketball players.

METHOD

Type of research

This research is based on the positivist view, which aims to make general inferences about the causes and consequences of observed phenomena and behaviors, and argues that the reality can be objectively observed, measured, analyzed and made functional by seeing the reality as independent from the researcher, and is based on the pre and post-test control group model, one of the quantitative research methods (Coşkun et al., 2015; Kozak, 2014).

Population and sample of the study

The population of the study consists of licensed male basketball players in Isparta. The sample of the study consists of 24 licensed male basketball players aged between 18-23 years living in Isparta. However, 18 licensed male basketball players participated in the study due to the injuries of the athletes and their withdrawal from the study.

Data collection method

An ‘Informed Voluntary Consent Form’ was obtained from the basketball players who volunteered for the study in order to inform them about the study and that the personal information and findings recorded during and after the study would be kept strictly confidential. Afterwards, an 8-question Personal Information Form was prepared to collect information about the personal characteristics of the basketball players. Before starting the measurements, a meeting was held with the basketball players and information about the research was given, and the athletes were informed about the foods that the basketball players should and should not consume during the research, and it was ensured that the athletes participated in the research more selflessly. Basketball players were randomly divided into three groups as L-Arginine group of 6, L-Arginine and vitamin C group of 6 and control group of 6. Aerobic conconi treadmill test and wingate anaerobic power tests were performed and data were recorded in the Performance Laboratory of Süleyman Demirel University, Faculty of Sports Sciences. There was a 48-hour washout period for the athletes.

Data collection tools

The devices used in the study (electronic scale, height scale, Conconi treadmill, Monark 894 E, Lactat scout and OKmeter Optima blood glucose meter) were suitable to achieve the targeted results. In the study, body weight, height, acute aerobic and anaerobic performance, blood glucose level and lactic acid level measurements were performed.

Conconi treadmill test

Conconi test was used to evaluate the aerobic performance of basketball players. The athletes were placed on a treadmill and warmed up for 5 minutes. After the warm-up was completed, the speed of the treadmill was set to 8.5 km/h in the 5th minute of the test and the speed was increased by 0.5 km/h every 200 meters. The test was terminated when the athletes reached the maximal loading level and could not continue the test (Açıkada et al., 2010).

Wingate anaerobic power test

It was used to evaluate the anaerobic performance of basketball players. Age, height and body weight values of each participant were recorded, and the test was started after the weights to be applied during the test were placed on the pans in the bicycle mechanism. They were asked to maintain the highest maximal voluntary pedal speed possible for 30 seconds, initially unloaded for 3-4 seconds and then loaded to reach a certain pedal speed (90 rpm). At the end of the test, peak power (PP) and minimum power (MP) values of the participants were recorded. The fatigue index (FI) was calculated by the formula stated by Inbar et al. (1996) (Koşar & İşler, 2004).

Lactic acid measurement

Lactic acid measurements were performed with a fingertip lactate scout device. Lactic acid analyses were repeated immediately after the Wingate anaerobic power and Conconi Treadmill test and 5 minutes later and the results were recorded. The measurement range was 0.5-25.0 mmol/L.

Blood glucose measurements

Blood glucose measurements were taken from the fingertip using OKmeter Optima Brand (OK-10H-Taiwan). Glucose measurements were recorded before and after Wingate anaerobic power and Conconi Treadmill test.

Nutritional supplements used in the study

In the study, the control group was given 2 grams of baking soda mixed into 200 ml of water as placebo, which has no calories, will not provide energy or affect performance. The experimental group was divided into two groups and one group was given vitamin C and L-Arginine and one group was given L-Arginine supplement. The supplements were obtained from a sports food store. One group was given 1 gram of effervescent tablet vitamin C and 2 grams of powdered L-Arginine mixed in 200 ml of water 1 hour before the test. The other group received 2 grams of L-Arginine powder mixed in 200 ml of water. The amounts of supplements given in the study were given in line with the information in the literature (Birol, 2018; Şeker, 2020).

Data analysis

The data collected from the study were analyzed using the licensed SPSS 29 statistical software. The demographic information of the athletes participating in the study was summarized and evaluated with minimum, maximum, x̄ (Arithmetic Mean) and SD (Standard Deviation) from descriptive statistics. In the study, 'paired t test' was used to evaluate the aerobic-anaerobic performance, glucose and lactate levels of basketball players and 'One-way ANOVA' test was used to determine the difference between the groups. The significance level was evaluated according to 0.05 level of significance.

FINDINGS

In this study, the analysis of the measurements taken from the athletes were statistically explained. In the tables given below, descriptive statistics, aerobic-anaerobic performance, lactic acid and blood glucose levels of the athletes before and after supplementation were compared.

Table 1. Descriptive statistics results of basketball players

Parameters	Groups	N	Minimum	Maximum	Mean±Sd
Age (years)	Placebo	6	19.00	22.00	20.33±1.21
	L-Arjinin	6	18.00	23.00	19.66±2.06
	L-Arjinin+C Vit.	6	18.00	23.00	20.83±1.94
Height (cm)	Placebo	6	171.00	192.00	183.16±8.54
	L-Arjinin	6	172.00	186.00	181±4.97
	L-Arjinin+C Vit.	6	172.00	191.00	182.83±7.62
Body Weight (kg)	Placebo	6	55.00	93.20	75.71±16.14
	L-Arjinin	6	60.60	72.50	68.38±4.52
	L-Arjinin+C Vit.	6	66.20	91.00	80.56±9.82

According to Table 1, the mean age of the placebo group was 20.33±1.21 years, the mean age of the L-Arginine group was 19.66±2.06 years and the mean age of the L-Arginine+ vitamin C group was 20.83±1.94 years. The mean height of the placebo group was 183.16±8.54 cm, the mean height of the group receiving L-Arginine was 181±4.97 cm and the mean height of the group receiving L-Arginine+ vitamin C was 182.83±7.62 cm. The mean body weight of the placebo group was 75.71±16.14 kg, the mean body weight of the group receiving L-Arginine was 68.38±4.52 and the mean body weight of the group receiving L-Arginine+ vitamin C was 80.56±9.82 kg.

Table 2. Intragroup comparison of basketball players' pre- and post-test results of before taking supplements (BTS) and after taking supplements (ATS) wingate anaerobic power test

Parameters	Groups	N	Supplement intake status	Mean±Sd	t	p
Peak Power (PP) (Watt)	Placebo	6	BTS	665.37±155.69	-0.311	0.769
			ATS	674.92±188.75		
	L-Arjinin	6	BTS	666.06±126.62	-1.639	0.162
			ATS	733.72±72.35		
	L-Arjinin+C Vit.	6	BTS	650.53±80.81	-5.760	0.002
			ATS	747.51±72.39		
Minimum Power (MP) (Watt)	Placebo	6	BTS	277.83±67.80	1.593	0.172
			ATS	245.83±77.80		
	L-Arjinin	6	BTS	255.41±38.50	-0.164	0.876
			ATS	259.48±32.68		
	L-Arjinin+C Vit.	6	BTS	302.08±53.48	1.402	0.220
			ATS	253.90±61.91		
Fatigue Index (%)	Placebo	6	BTS	55.46±6.67	-2.465	0.057
			ATS	63.27±8.31		
	L-Arjinin	6	BTS	60.50±8.57	-0.865	0.427
			ATS	64.23±6.36		
	L-Arjinin+C Vit.	6	BTS	53.07±8.96	-2.746	0.040
			ATS	66.01±7.49		

*=p<0.05

Table 2 indicates that, when examining the results of the BTS and ATS Wingate anaerobic power tests of the athletes, a statistically significant difference was observed in peak power and fatigue index values in the L-Arginine+Vit. AG group (p<0.05), but not in MP values (p>0.05). Additionally, no statistically significant difference was found in the intra-group comparison of PP, MP, and fatigue index values between BTS and ATS in the placebo and L-Arginine AG groups (p>0.05).

Table 3. Intergroup comparison of BTS and ATS wingate anaerobic power test pre and post test results of basketball players

Parameters	Groups	N	Supplement intake status	Mean±Sd	F	p
Peak Power (PP)(Watt)	Placebo	6	BTS	665.37±155.69	0.030	0.971
	L-Arjinin	6		666.06±126.62		
	L-Arjinin+C Vit.	6		650.53±80.81		
	Placebo	6	ATS	674.92±188.75	0.580	0.572
	L-Arjinin	6		733.72±72.35		
	L-Arjinin+C Vit.	6		747.51±72.39		
Minimum Power (MP) Watt)	Placebo	6	BTS	277.83±67.80	1.097	0.359
	L-Arjinin	6		255.41±38.50		
	L-Arjinin+C Vit.	6		302.08±53.48		
	Placebo	6	ATS	245.83±77.80	0.077	0.926
	L-Arjinin	6		259.48±32.68		
	L-Arjinin+C Vit.	6		253.90±61.91		
Fatigue Index (%)	Placebo	6	BTS	55.46±67.00	1.306	0.300
	L-Arjinin	6		60.50±8.57		
	L-Arjinin+C Vit.	6		53.07±8.96		
	Placebo	6	ATS	63.27±8.31	0.211	0.812
	L-Arjinin	6		64.23±6.36		
	L-Arjinin+C Vit.	6		66.01±7.49		

*=p<0.05

Table 3 demonstrates that there were no statistically significant distinctions (p>0.05) in the comparison of athletes' anaerobic performance values between the groups, regarding BTS and ATS, as well as PP, MP, and Fatigue index.

Table 4. Intergroup comparison of pre and post test results of wingate anaerobic power test BTS and ATS glucose values of basketball players

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	t	p
Glucose (mg/dl)	Placebo	6	BTS	Pre-test Post-test	101.66±14.85 88.33±7.81	2.156	0.084
	L-Arjinin	6		Pre-test Post-test	91.33±5.81 92.33±7.84	-0.221	0.834
	L-Arjinin+C Vit.	6		Pre-test Post-test	88.83±6.58 90.50±9.85	-0.339	0.748
	Placebo	6	ATS	Pre-test Post-test	89.83±9.53 92.50±14.73	-0.376	0.722
	L-Arjinin	6		Pre-test Post-test	92.66±9.02 93.50±12.21	-0.132	0.900
	L-Arjinin+C Vit.	6		Pre-test Post-test	89.50±9.89 86.83±15.32	0.549	0.607

*=p<0.05

Table 4 indicates that there were no statistically significant disparities observed in the pre-test and post-test glucose values of the athletes' Wingate Anaerobic Power Test BTS and ATS across any of the groups (p>0.05).

Table 5. Intergroup comparison of pre and post test results of wingate anaerobic power test BTS and ATS glucose values of basketball players

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	F	p
Glucose (mg/dl)	Plasebo L-Arjinin L-Arjinin+C Vit.	6 6 6	BTS	Pre-test	101.66±14.85 91.33±5.81 88.83±6.58	2.797	0.093
	Plasebo L-Arjinin L-Arjinin+C Vit.	6 6 6		Post-test	88,33±7.81 92.33±7.84 90,50±9.85	0.329	0.725
	Plasebo L-Arjinin L-Arjinin+C Vit.	6 6 6	ATS	Pre-test	89.83±9.53 92.66±9.02 89.50±9.89	0.202	0.820
	Plasebo L-Arjinin L-Arjinin+C Vit.	6 6 6		Post-test	92.50±14.73 93.50±12.21 86.33±15.32	0.387	0.686

*=p<0.05

Table 5 indicates that there was no statistically significant distinction between the groups in the pre-test and post-test glucose values of the Wingate anaerobic power test BTS and ATS (p>0.05).

Table 6. Intragroup comparison of wingate anaerobic power test BTS and ATS lactic acid values of basketball players immediately after test and 5 minutes after test

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	t	p
La (mmol/L)	Placebo	6	BTS	Immediately after 5 minutes later	14.10±4.97 13.40±3.09	0.364	0.731
	L-Arjinin	6		Immediately after 5 minutes later	14.60±4.26 12.41±3.32	1.992	0.103
	L-Arjinin+C Vit.	6		Immediately after 5 minutes later	15.23±2.71 14.21±3.96	0.522	0.624
	Placebo	6	ATS	Immediately after 5 minutes later	15.80±1.54 14.65±.850	2.438	0.059
	L-Arjinin	6		Immediately after 5 minutes later	15.91±2.60 13.20±3.15	2.978	**0.031**
	L-Arjinin+C Vit.	6		Immediately after 5 minutes later	15.53±3.69 10.56±2.25	6.054	**0.002**

*=p<0.05

When Table 6 is examined; while there was no statistically significant difference in lactic acid values in any of the groups as a result of Wingate Anaerobic Power Test performed by BTS (p>0.05), there was a statistically significant difference in La values immediately after the test and 5 min after the test in ATS; L-Arginine and L-Arginine+C Vit. A statistically significant difference was found in La values immediately after the test and 5 min after the test in ATS (p<0.05).

Table 7. Intergroup comparison of wingate anaerobic power test BTS and ATS lactic acid values of basketball players immediately after test and 5 minutes after test

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	F	p	LSD
La(mmol/L)	[a]Placebo	6	BTS	Immediately after	14.10±4.97	0.115	0.892	
	[b]L-Arjinin	6			14.60±4.26			
	[c]L-Arjinin +C Vit.	6			15.23±2.71			
	[a]Placebo	6		5 minutes later	13.40±3.09	0.402	0.676	
	[b]L-Arjinin	6			12.41±3.32			
	[c]L-Arjinin +C Vit.	6			14.21±3.96			
	[a]Placebo	6	ATS	Immediately after	15.80±1.54	0.030	0.970	
	[b]L-Arjinin	6			15.91±2.60			
	[c]L-Arjinin +C Vit.	6			15.53±3.69			
	[a]Placebo	6		5 minutes later	14.65±0.85	4.900	**0.023**	**c>a**
	[b]L-Arjinin	6			13.20±3.15			
	[c]L-Arjinin +C Vit.	6			10.56±2.25			

*=p<0.05 a=plasebo b=L-Arjinin c=L-Arjinin+C Vit.

Upon reviewing Table 7, it's evident that there was no statistically significant contrast in lactic acid values following the Wingate Anaerobic Power Test with BTS across any group (p>0.05). However, a statistically significant distinction was observed between the L-Arginine

+ vitamin C AG and placebo group regarding lactic acid values after the Wingate Anaerobic Power Test with ATS (p<0.05).

Table 8. Intragroup comparison of pre and post test results of BTS and ATS aerobic performance values of basketball players

Parameters	Groups	N	Supplement intake status	Mean±Sd	t	p
Aerobic Performance Running Distance (m)	Placebo	6	BTS	2020.66±135.10	-0.599	0.575
			ATS	2051.50±84.54		
	L-Arjinin	6	BTS	2123.16±806.28	-4.254	0.008
			ATS	2550.50±954.18		
	L-Arjinin+C Vit.	6	BTS	2130.50±417.10	-3.762	0.013
			ATS	2663.83±683.94		
Aerobic Performance Running time (sec)	Placebo	6	BTS	750.66±84.43	-0.812	0.454
			ATS	765.33±58.56		
	L-Arjinin	6	BTS	757.50±199.36	-3.570	0.016
			ATS	927±250.89		
	L-Arjinin+C Vit.	6	BTS	866.83±121.20	-3.296	0.022
			ATS	975.83±149.92		

*=p<0.05

When Table 8 is examined, as a result of the Conconi test performed by BTS and ATS, a statistically significant difference was found in aerobic performance values, running distance and running time values in L-Arginine and L- Arginine+Vitamin C AG (p<0.05), while no statistically significant difference was found in running distance and running time values in the placebo group (p>0.05).

Table 9. Intergroup comparison of pre and post test results of BTS and ATS aerobic performance values of basketball players

Parameters	Groups	N	Supplement intake status	Mean±Sd	F	p
Aerobic Performance Running Distance (m)	[a]Placebo	6	BTS	2020.66±135.10	0.310	0.738
	[b]L-Arjinin	6		2123.16±806.28		
	[c]L-Arjinin +C Vit.	6		2130.50±417.10		
	[a]Placebo	6	ATS	2051.50±84.54	1.379	0.282
	[b]L-Arjinin	6		2550.50±954.18		
	[c]L-Arjinin +C Vit.	6		2663.83±683.94		
Aerobic Performance Running time (sec)	[a]Placebo	6	BTS	750.66±84.43	1.242	0.317
	[b]L-Arjinin	6		757.50±199.36		
	[c]L-Arjinin +C Vit.	6		866.83±121.20		
	[a]Placebo	6	ATS	765.33±58.56	2.459	0.119
	[b]L-Arjinin	6		927±250.89		
	[c]L-Arjinin +C Vit.	6		975.83±149.92		

*=p<0.05 a=plasebo b=L-Arjinin c=L-Arjinin+C Vit.

When Table 9 is examined, no statistically significant difference was found in the scores between the groups in the anova test performed for the comparison of BTS and ATS aerobic performance values (p>0.05). However, when the running distance and running time values of the athletes after supplementation were analyzed, there was an increase in values in all groups (placebo, L-Arginine AG and L-Arginine + Vit. C AG), although not significant.

Table 10. Intragroup comparison of pre and post test results of aerobic conconi running test BTS and ATS glucose values of basketball players

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	t	p
Glucose (mg/dl)	Placebo	6	BTS	Pre test	88±7.37	1.042	0.345
				Post test	84.83±7.57		
	L-Arjinin	6		Pre test	91.66±5.98	0.705	0.512
				Post test	90.33±2.16		
	L- Arjinin+C Vit.	6		Pre test	92.33±6.88	-0.423	0.690
				Post test	93.83±9.64		
	Placebo	6	ATS	Pre test	89.50±5.82	0.925	0.397
				Post test	86.16±7.83		
	L-Arjinin	6		Pre test	91.83±3.60	-0.059	0.955
				Post test	92±8.07		
	L-Arjinin+C Vit.	6		Pre test	91.33±2.50	-0.643	0.548
				Post test	93.33±6.86		

*=p<0.05

Table 10 demonstrates that the pre-test and post-test values of the Aerobic Conconi Running Test BTS and ATS glucose levels in basketball players exhibited no statistically significant disparity (p>0.05).

Tablo 11. Intergroup comparison of pre and post test results of aerobic conconi running test BTS and ATS glucose values of basketball players

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	F	p
Glucose (mg/dl)	[a]Placebo	6	BTS	Pre test	88±7.37	0.712	0.507
	[b]L-Arjinin	6			91.66±5.98		
	[c]L-Arjinin +C Vit.	6			92.33±6.88		
	[a]Placebo	6		Post test	84.83±7.57	2.390	0.126
	[b]L-Arjinin	6			90.33±2.16		
	[c]L-Arjinin +C Vit.	6			93.83±9.64		
	[a]Placebo	6	ATS	Pre test	89.50±5.82	0.511	0.610
	[b]L-Arjinin	6			91.83±3.60		
	[c]L-Arjinin +C Vit.	6			91.33±2.50		
	[a]Placebo	6		Post test	86.16±7.83	1.506	0.253
	[b]L-Arjinin	6			92±8.07		
	[c]L-Arjinin +C Vit.	6			93.33±6.86		

*=p<0.05 a=plasebo b=L-Arjinin c=L-Arjinin+C Vit.

Table 11 indicates that there were no statistically significant variances between the groups in the BTS and ATS glucose values of basketball players during the Aerobic Conconi Running Test (p>0.05).

Table 12. Intragroup comparison of aerobic conconi running test BTS and ATS lactic acid values of basketball players immediately after test and 5 minutes after test

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	t	p
La (mmol/L)	Placebo	6	BTS	Immediately after	16.83±4.84	1.831	0.127
				5 minutes later	14.25±3.25		
	Arjinin	6		Immediately after	16.91±1.84	1.901	0.116
				5 minutes later	15.76±1.58		
	Arjinin+C Vit.	6		Immediately after	15.50±1.76	2.150	0.084
				5 minutes later	14.18±1.16		
	Placebo	6	ATS	Immediately after	17.38±1.77	2.135	0.086
				5 minutes later	15.83±.0.74		
	Arjinin	6		Immediately after	16.48±2.07	3.959	**0.011**
				5 minutes later	13.23±1.61		
	Arjinin+C Vit.	6		Immediately after	16.03±2.35	5.019	**0.004**
				5 minutes later	12.88±3.16		

*=p<0.05

When Table 12 is examined; while no statistically significant difference was found in lactic acid values in any of the groups as a result of the aerobic conconi running test performed by BTS in basketball players (p>0.05), a statistically significant difference was found in lactic acid values in L-Arginine AG and L-Arginine + Vit. C as a result of the aerobic conconi running test performed by ATS (p<0.05). AG, a statistically significant difference was found in lactic acid values (p<0.05).

Table 13. Intergroup comparison of aerobic conconi running test BTS and ATS lactic acid values of basketball players immediately after and 5 minutes after the test

Parameters	Groups	N	Supplement intake status	Tests	Mean±Sd	F	p
La (mmol/L)	[a]Placebo	6	BTS	Immediately after	16.83±4.84	0.379	0.691
	[b]L-Arjinin	6			16.91±1.84		
	[c]L-Arjinin +C Vit.	6			15.50±1.76		
	[a]Placebo	6		5 minutes later	14.25±3.25	0.997	0.392
	[b]L-Arjinin	6			15.76±1.58		
	[c]L-Arjinin +C Vit.	6			14.18±1.16		
	[a]Placebo	6	ATS	Immediately after	17.38±1.77	0.654	0.534
	[b]L-Arjinin	6			16.48±2.07		
	[c]L-Arjinin +C Vit.	6			16.03±2.35		
	[a]Placebo	6		5 minutes later	15.83±.0.74	3.555	0.054
	[b]L-Arjinin	6			13.23±1.61		
	[c]L-Arjinin +C Vit.	6			12.88±3.16		

*=p<0.05 a=plasebo b=L-Arjinin c=L-Arjinin+C Vit.

Table 13 demonstrates that there were no statistically significant discrepancies (p>0.05) in the lactic acid values immediately post-test and 5 minutes post-test when comparing the Aerobic Conconi Running Test BTS and ATS lactic acid values among basketball players across the groups.

DISCUSSION AND CONCLUSION

Athletes frequently use nutritional ergogenic supplements to improve their performance, increase their strength and endurance, remove substances accumulated after exercise and recover (Bayram & Öztürkcan, 2020). L-Arginine, which is thought to have positive effects on performance and to help remove lactic acid, which causes muscle fatigue such as lactic acid, from the body, is one of the frequently used nutritional ergogenic supplements (Birol, 2018). In addition, athletes use vitamin C supplements to protect their immunity and improve their performance. Studies have shown that L-Arginine and vitamin C have effects on sportive performance and blood parameters, but we think that more studies are needed because there are not enough studies. The aim of this study was to investigate the acute effects of L-Arginine and vitamin C intake on aerobic- anaerobic performance, lactic acid and blood glucose parameters in basketball players.

In the results of anaerobic power test measurements in this study; while there was a statistically significant difference in the peak power values of the groups before and after supplementation; in the group receiving L-Arginine + vitamin C (p<0.05). Although the peak power values of the placebo group and the group receiving L-Arginine increased before and after supplementation, no statistically significant difference was found (p>0.05) (Table 2). Although peak power values were not statistically significant between the groups, improvement was observed in all groups in line with the supplements given (Table 3). The minimum power values of the groups were found to be statistically insignificant (p>0.05) in the test measurements before and after supplementation (Table 2). There was no significant difference between the minimum power values of the groups before and after supplementation (Table 3). Fatigue index values (%) before and after supplementation showed a statistically significant difference in the group receiving L-Arginine + vitamin C (p<0.05), while the fatigue index values of the placebo group and the group receiving L-Arginine increased before and after supplementation, but no statistically significant difference was found (p>0.05) (Table 2). Although fatigue index values were not statistically significant between the groups, improvement was observed in all groups in line with the supplements given (Table 3). The increase in fatigue index values increased in parallel with peak power values. Birol (2018) found that oral L-Arginine supplementation at a relative dose of 0.15 g/kg/day did not improve anaerobic performance. Bailey et al. (2010) observed in a study that L-Arginine supplementation extended the time to exhaustion during intense exercise. Similarly, Mor et al. (2018), in their study examining the effect of L-Arginine supplementation on anaerobic power and recovery, noted an increase in peak power values in both the L-Arginine and placebo groups, consistent with our findings, but found no statistically significant difference. In the literature, there are studies on the use of L-Arginine and vitamin C separately. While some studies have found that they have positive effects on anaerobic performance, there are also studies that found that they do not contribute to performance. In our study, it was observed that the use of L-Arginine + vitamin C together contributed positively to anaerobic performance. We think that this may be due to the fact that vitamin C may have increased the absorption of L-Arginine.

In our study, no statistically significant differences were observed in the glucose values of the groups in the pre-test and post-test results of the anaerobic power test before and after supplementation (p>0.05) (Table 4). Similarly, no statistically significant differences were found between the groups when comparing the pre-test and post-test values of the anaerobic power test before and after supplementation (p>0.05) (Table 5). We believe that acute intake of L-Arginine and L-Arginine with vitamin C had no effect on blood glucose levels. Yılmaz (2016) investigated the hormonal and metabolic impacts of immediate L-Arginine supplementation during strength training, concluding that it did not affect blood glucose levels. Similarly, Hiratsu et al. (2022) conducted a study exploring the consequences of both short-term and long-term L-Arginine consumption, proposing that immediate intake of L-Arginine did not influence blood glucose levels. Aksak (2010), in a study conducted on athletes engaged in football and basketball branches, found that the blood glucose level of basketball players increased after exercise compared to pre-exercise, but there was no significant difference.

When the literature was examined, it was concluded that acute L-Arginine and vitamin C intake did not have any effect on blood glucose levels during anaerobic exercise, which is similar to the results we obtained in this study.

In our study, lactic acid values before anaerobic power test supplementation were measured immediately after the test and 5 min after the test and no statistically significant difference was found in any group (p>0.05) (Table 6). When the lactic acid values after supplementation in the anaerobic power test were analyzed, a statistically significant difference was found in the L-Arginine and L-Arginine+Vitamin C groups immediately after the test and 5 min after the test ($p<0.05$) (Table 6). When the lactic acid values before supplement intake and immediately after the test and 5 min after the test after supplement intake were compared between the groups, a statistically significant difference was found between the group taking L-Arginine + vitamin C and the placebo group in supplement lactic acid values ($p<0.05$) (Table 7). We think that the use of L-Arginine + vitamin C may be more effective in preventing lactic acid accumulation than L-Arginine. Yavuz (2007), in his study to see the effects of oral L-Arginine supplementation on lactate threshold and lactate metabolism, the desired decrease in lactic acid values was experienced in the recovery process after exercise in the group receiving L-Arginine, but no statistically significant difference was found. Schaefer et al. (2002) reported that L-Arginine supplementation given before maximal exercise reduced the amount of lactic acid resulting from exercise. Koçyiğit et al. (2011) concluded in a study that daily intake of 1 g vitamin C decreased lactate dehydrogenase after exercise in basketball players compared to pre-exercise. Bryant et al. (2003), in a study on 7 trained cyclists, found that 1 g of vitamin C intake did not make a significant difference in lactic acid values.

In the aerobic performance test measurements of the groups in our study, a statistically significant difference was found in the values of running distance and running time before and after supplementation in the group receiving L-Arginine and L-Arginine + vitamin C ($p<0.05$) (Table 8). When running distance and running time were compared between the groups, no statistically significant difference was found between the groups ($p>0.05$) (Table 9). However, improvement in aerobic performance was found in all groups. Bailey et al. (2010), in the aforementioned study, stated that 6 g L-Arginine supplementation reduces oxygen consumption in moderate intensity exercise, which indirectly reduces the cost of power generation and may improve aerobic performance. These studies have results that support our study. Ataka et al. (2007) reported that 1000 mg vitamin C intake did not improve performance in their study. Cholewa et al. (2008) concluded that 240 mg vitamin C supplementation had no effect on performance in basketball players.

In our study, no statistically significant difference was found in the glucose values of the groups in the pre-test and post-test results of the aerobic performance test before and after supplementation ($p>0.05$) (Table 10). There was no statistically significant difference between the groups in aerobic performance test pre-test and post-test values before and after supplementation ($p>0.05$) (Table 11). We think that acute L-Arginine and L-Arginine+C intake had no effect on blood glucose levels in our study. Forbes et al. (2013) concluded that L-

Arginine supplementation 60 minutes before submaximal exercise had no effect on blood glucose levels. Colombani et al. (1999) reported that 15 g L-Arginine aspartate supplementation given to 14 marathon runners 1 hour before exercise did not change blood glucose levels. These studies are similar to the results obtained in our study. In our study, an increase in blood glucose levels was observed in the L-Arginine group during aerobic and anaerobic exercise after supplementation. However, it cannot be concluded whether this increase is due to L-Arginine intake or exercise. Aydın et al. (2000) stated in their study that there was an increase in blood glucose levels after aerobic and anaerobic exercise in soccer players.

In our investigation, we observed no statistically significant distinction in lactate levels immediately after and 5 minutes after the aerobic Conconi running test before supplement intake ($p > 0.05$). Nonetheless, upon analyzing lactate levels after supplement intake, significant differences emerged immediately after and 5 minutes after the test among the groups administered L-Arginine and L-Arginine + Vitamin C ($p < 0.05$) (Table 12). Based on these results, we can say that L-Arginine and L-Arginine+C vitamin may have an impact on recovery. Before and after supplement intake, there was no statistically significant difference in lactate values immediately after and 5 minutes after the test between groups ($p > 0.05$) (Table 13). Despite the lack of significant difference, we can say that during the recovery period after exercise, L-Arginine and L-Arginine+C vitamin supplements provided the desired decrease in lactate levels. Alvares et al. (2014) conducted a study on 16 healthy runners, measuring lactate immediately after and 20 minutes after a 5 km time trial run. They observed a significant decrease in plasma lactate concentration after 20 minutes of rest. Similarly, Burtscher et al. (2005) investigated the effects of L-Arginine-L-Aspartate intake on lactate accumulation during submaximal exercise. They reported that pre-exercise supplementation with 3 grams of L-Arginine-L-Aspartate reduced lactate accumulation after exercise. Kırıkoğlu (2002) found that 1000 mg of vitamin C did not lead to any changes in post-exercise lactate levels. In our study, the results indicated that there was a statistically significant difference only in aerobic running performance values and lactate levels obtained from the aerobic-anaerobic test with the intake of L-Arginine alone. While there was no significant difference found in the anaerobic performance test, upon further examination, it was observed that anaerobic performance improved. In the case of L-Arginine + Vitamin C intake, statistically significant differences were observed in aerobic-anaerobic performance and lactate levels. However, in both groups, there was no statistically significant difference in blood glucose levels before and after aerobic and anaerobic performances. Therefore, considering this study, we believe that the intake of L-

Arginine + Vitamin C may reduce accumulated lactate levels after exercise and contribute to both aerobic and anaerobic performance. We also believe that the data obtained from this study will serve as reference values for future research and sports scientists.

Recommendations

In future studies, the duration of the study could be extended to examine the chronic effects of L-Arginine and Vitamin C intake.

This study was conducted on basketball players in a laboratory setting. It is recommended that future studies be conducted during training or competition times to examine the effects of L-Arginine + Vitamin C intake on athletes' performance.

The study was conducted in basketball where both aerobic and anaerobic performance are important. Studies examining the effect of L-Arginine + Vitamin C on athletic performance can be conducted in different sports branches.In future studies, the amount of L-Arginine + Vitamin C supplementation given to athletes can be increased within the range recommended by the U.S. Olympic Committee (USOC).

Studies conducted in different age groups and different sports branches in both genders are believed to contribute to the literature.

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KATKI ORANI ***CONTRIBUTION RATE***	**AÇIKLAMA** ***EXPLANATION***	**KATKIDA BULUNANLAR** ***CONTRIBUTORS***
Fikir ve Kavramsal Örgü *Idea or Notion*	Araştırma hipotezini veya fikrini oluşturmak *Form the research hypothesis or idea*	Gülşen KARATAY Gürhan SUNA
Tasarım *Design*	Yöntem ve araştırma desenini tasarlamak *To design the method and research design.*	Gülşen KARATAY Gürhan SUNA
Literatür Tarama *Literature Review*	Çalışma için gerekli literatürü taramak *Review the literature required for the study*	Gülşen KARATAY Gürhan SUNA Emrah YILMAZ
Veri Toplama ve İşleme *Data Collecting and Processing*	Verileri toplamak, düzenlemek ve raporlaştırmak *Collecting, organizing and reporting data*	Gülşen KARATAY
Tartışma ve Yorum *Discussion and Commentary*	Elde edilen bulguların değerlendirilmesi *Evaluation of the obtained finding*	Gülşen KARATAY Gürhan SUNA Emrah YILMAZ

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Etik Kurul Beyanı/ *Statement of Ethics Committee*

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