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ACUTE EFFECTS OF TWO ENERGY DRINKS ON ANAEROBIC POWER AND BLOOD LACTATE LEVELS IN MALE ATHLETES

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Karim Azali Alamdari[1,2], Mohammadreza Kordi[2*], Siroosce Choobineh[2], Asghar Abbasi[1]

[1]Department of Physical Education and Sport Science, Faculty of Humanities and Educational Science, Islamic Azad University, Tabriz branch, Tabriz, Iran
[2]Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran
[*]E-mail: mrkordi@ut.ac.ir

Abstract. *Nowadays, consumption of supplements and energy drinks is very common among athletes. However, there are limited studies in support of the necessity for energy drink consumption, before and during short term intensive exercises. There is also no data on the qualitative ranking of these products in delaying fatigue and the onset of lactate accumulation. The aim of this research was to investigate the acute effects of two energy drinks (ORGAZMA and MegaBasic) on the anaerobic power and blood lactate levels in male athletes. Thirty well-trained male athletes who were students volunteered (age: 22.34±1.74 years, height: 181.26±7.66 cm, weight: 76.37±6.85 kg and BF%: 13.2±2.7%) were randomly selected to participate in this study. This research was conducted on two separate sessions with four days of rest in between. In the first session, all of the subjects participated in the RAST test after having a standard breakfast and after having their blood lactate levels measured via the unpreferred hand mid-fingertip blood samples by a certificated lactometer in three phases[1); prior to test beginning, 2 and 3); two and six minutes after the test was finished]. In the second session, the subjects were randomly divided into three groups (Placebo, OR and MegaBasic). Then, each group received 6 ml/kg.bw of related beverages (forty minutes prior to the RAST test) immediately after having breakfast. Afterwards, the subjects participated in a RAST test for a second time. Our results showed that in the OR group, the minimum and mean power were increased respectively 11.01% and 9.15% and that the blood lactate levels which were measured two minutes after the RAST test, were decreased 3.63% ($p<0.05$). It can be inferred that ORGAZMA can be considered an ergogenic agents, but it appears that the ergogenic capacity of this energy drink is probably limited and transient in the case of acute administration.*

Key words: *energy drink, anaerobic power, blood lactate, acute effects*

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1. INTRODUCTION

Although in recent years, athletes have improved their performance levels, they share the same quest with their historical counterparts: success and victory at the Olympic Games. So every time, very different methods were tried by athletes to achieve this aim. In this way, consumption of energy drinks by athletes has become increasingly popular. Athletes believe that energy drinks can be used to enhance their performance during training and competition due to their potentially ergogenic ingredients such as carbohydrates, caffeine, sodium and taurine, among others.

Sport drink consumption is recommended for most sports and not all of the sport beverages are the same. They differ in type and concentration of carbohydrates, electrolytes, flavors and other constituents. Some simply replace carbohydrates and electrolytes; others provide added protein, specific amino acids, and even fat, while still others provide herbs, vitamins, and caffeine (Maurer, 2005).

Energy or 'power' drinks (e.g., Battery, B52, Dark Dog, Jess, Red Bat, Red Bull, Rhino's) are beverages designed and consumed for purposes other than for improving athletic performance: for instance, to reduce the depressant effects of alcohol on the central nervous system. On the other hand, sports and fluid-electrolyte replacement beverages (e.g., Gatorade, Powerade) are designed and consumed to enhance athletic performance or to reduce the deleterious effects of dehydration during athletic competitions (Carvajal- Sancho, Moncada- Jiménez, 2005).

It should be noted that, although energy drinks have been sold worldwide for more than a decade, unfortunately only a few studies have apparently been published to test the effectiveness of these beverages on the physical or cognitive performance in athletes (Alford, Cox, & Wescott, 2001; Baum & Weib, 2001; Carvajal- Sancho & Moncada- Jiménez, 2005). So far, no data is available in regard to the effectiveness these beverages on anaerobic power and the delay of blood lactate accumulation.

Some scientific studies with similar topics will cited later on. Nevertheless, in most cases, their topics were not directly related to anaerobic power or delaying blood lactate accumulation.

Alford et al. (2001) investigating the effects of an energy drink (Red Bull) on psychomotor, anaerobic and aerobic performance (anaerobic performance was measured by a 20s cycle ergometer test), reported that the Red Bull group improved aerobic and anaerobic performance by 9% and 24%, respectively. Similarly, Carvajal- Sancho & Moncada- Jiménez (2005) studied the acute effect of an energy drink on physical performance (100 m sprint, hand dynamometer and standing long jump) and indicated no significant changes in physical and cognitive variables. In another research, the influence of a multivitamin/mineral supplement on anaerobic exercise performance (a 30-second cycle sprint test and one set of squat exercise) was studied by Fry et al. (2006) and a decreased rate of fatigue was noted for both exercise tests. In addition, Olson and Seifert (2004) carried out a study to determine if consumption of a carbohydrate-protein drink could improve skating performance. The results showed that, in the experimental group, speed performance improved by 8% and reaction time improved by 12%. Kipp et al. (2003) also investigated the influence of a carbohydrate/protein sports drink on soccer sprint performance **(**four speed trials with 5 min of rest in between). In the carb-protein group, speed was improved between the first and last sprints by 1.1 seconds, while the other group slowed down by 2.2 seconds.

There are many types of energy drinks which can be purchased over the counter by everyone and their producers have claimed a variety of benefits in their advertisements. Two kinds of these beverages have claimed to be able to delay blood lactate accumulation, fatigue onset and help to improving performance. Theoretically, an alkalinizing content can be considered as a possible way to explain the efficiency of energy drinks. It is well known that alkalinizing agents can increase blood pH, $HCO3^-$concentration, and base excess in extracellular fluids. Therefore, a greater extracellular bufferic concentration leads to a favorable pH gradient for efflux of intracellular lactate and H^+ into the extracellular fluids. In the case of an intensively working skeletal muscle, this means a delay in the fall in intramuscular pH to the critical level at which glycolysis is inhibited (Oo¨pik et al., 2003; MacDougall et al., 1991). On the other hand, with regard to controversial reports about the effects of alkalinizing agents in the case of acute administration (Stout & Antonio, 2002; Aschenbach et al., 2000; Bishop et al., 2004; Marx et al., 2002; McNaughton et al., 1999; Ball and Maughan, 1997; Wilkes et al., 1983), it is unclear whether the consumption of energy drinks can have such effects.

By a simple review of the existing literature, it would appear that hardly any studies have clarified these claims. There is also a lack of research on the qualitative ranking of these products. So, further research is required in this area. Therefore, based on the previous background, this is the first study that has been designed to evaluate the acute effects of energy drinks on anaerobic power and blood lactate levels in male athletes.

2. METHOD

Participants: The study protocol was approved by the Tehran University Institutional Ethics Review Board. In order to be eligible to participate in the study, subjects had to meet the following inclusion criteria which were obtained by means of a questionnaire: a) to train for competition at least four days per week (approximately 30 min in each session); b) to be a moderate coffee consumer (2-4 cups·d-1); c) not to be on medication or nutritional supplementation; and d) not to consume energy drinks regularly. Potential participants were excluded from the study if they: a) presented psychiatric or neurological diseases; b) were sensitive to any ingredient contained in the energy drink; c) were under any nutritional supplementation regimen that included either caffeine, guarana, taurine or inositol; d) had participated in any pharmacological study in the previous three months; or e) had evident cardiac problems (Carvajal- Sancho and Moncada- Jiménez, 2005).

Thirty well trained male football players (age: 22.34±1.74 years, height: 181.26±7.66 cm, weight: 76.37±6.85 kg and BF%: 13.2±2.7%) volunteered to participate in this study (their running time over 400m was 51.22±1.74 s). The volunteers read and signed an informed consent form with a medical history questionnaire before beginning the study. Then, the nature of the study was explained to the subjects, and they were given an opportunity to ask questions about anything that was unclear.

Instruments: Anaerobic power was measured by a RAST[1] test. This test was chosen primarily due to its validity and reliability in relation to the Wingate test and also, because this test requires minimal equipment and training of the assessors and because of its specialty for field based anaerobic activities that are of a repetitive nature. It is easy to

[1] Running Based anaerobic sprint test

perform, provides scores that are easily reproduced and can be used to successfully estimate anaerobic capacity (Ghoudarzi, 2002, Zacharogiannis et al., 2004). In order to carry out a correct and precise testing process, the subjects stood 70 cm in the back of the starting line (on each side) and the apparatus would let the timer start after the subject passed in front of the first photocell. It was also decided that if in any of the cases the subject's best record was achieved after the second repetition, the test process should be finished and the subject was allowed to have another opportunity to participate in the test. To avoid these unwanted cases, subjects were asked to do each repetition at maximum power and avoid dividing energy between the six repetitions. Also in order to increase the subjects' motivation, the record of each repetition was announced loudly and there were special rewards for three individuals who could achieve the best record in each session, in addition to the payment in consideration of all the participants (Ghoudarzi, 2002).

Blood samples were collected from unpreferred hand mid-fingertips three times [1) immediately prior to the RAST test (pre-lac), 2,3) two and six minutes after the RAST test (2lac and 6lac)] for the purpose of estimating blood lactate using a lactate analyzer (Analox P-LM55, UK) found in an Analox lactate kit supplied by Analox (UK). It should be noted that, the analyzer had been calibrated with known lactate standards (5.0 and 15.0 mM).

Since environmental conditions can affect blood lactate levels and performance (Vachon et al. 1999), air temperature and relative humidity values for the track were recorded (21.7 ± 5.9, and 21.2 ± 2.3°C, and 48.4 ± 11.9, and 52.1 ± 9.7%, for first and second sessions respectively) using an Arco device (Model TC14P; Germany)

Procedure: This study was designed in a double-blind, placebo-controlled fashion. Two experimental conditions were tested: a) control (no drink); b) energy drink & placebo. During each testing session, the sequence of beverage consumption was counterbalanced to minimize the influence of the order of the effects (Byars et al., 2006).

One-week before the data collection took place, the participants were instructed on how to perform the RAST test and underwent a familiarization session (after performing 400m running test). The subjects were instructed to avoid alcohol, nicotine and other stimulants and also avoid strenuous activities and sudden changes in food consumption (including any nutritional supplementation products) the day before the experiment. In addition, they were asked to maintain regular physical activities during the days prior to the experiment, as recommended by Carvajal-Sancho and Moncada-Jiménez (2005). Moreover, they were asked to wear comfortable, loose-fitting clothing and get an adequate amount of sleep (6 to 8 hours) the night before the test (Byars et al., 2006). The clothing, shoes, as well as all equipment used, were consistent for each subject and were recorded to establish controlled experimental conditions.

Experimental protocol: In the first session, the subjects arrived at the stadium at 8:00 a.m. in a fasted state and a standardized breakfast (approximately 380 kcal) was served. Then, the subjects were taken to a synthetic track (where the RAST test was performed). Since the RAST test is an all-out test, the subjects warmed up for at least 25 min. The warm-up was standardized for all of the participants (Carvajal-Sancho and Moncada-Jiménez 2005). During the RAST test, the time of each repetition and the rest intervals was measured by an automatic timing photo-cell system. By 10:00 a.m., the subjects had finished their experimental session for that day and an appointment was made for them to return to the laboratory four days later.

The second session was similar to the first one; nevertheless, after having breakfast, the subjects were randomly divided into three groups (ORGAZMA, MegaBasic and Placebo). Afterwards the related beverages were assigned by properly trained staff in double-blind order and the athletes were told they would consume three different beverages. Each group received 6 ml/kg.bw of related beverages [with respect to the mean body weight of the ORGAZMA, MegaBasic and placebo groups (78.57±15.89, 77.14±10.23, and 73.37±14.71 kg, respectively), the subjects consumed a mean volume of 472 ml, 463 ml and 440 ml in three groups respectively]. These beverages were served cooled in 250 ml glasses and the staff ensured that athletes consumed all the given beverages. It should be noted that citrus flavored water was consumed as placebo beverages (Byars et al 2006). The ORGAZMA energy drink contains 48 kcal/100 ml, and its ingredients are as follows: water, sucrose, glucose (11.5 g/dl), sodium citrate, citric acid, taurine 4000 mg/l), glucuronolactone (2400mg/l), inosit, caffeine (320 mg/l), ginseng extract (50 mg/l), aromas, vitamins and coloring E150d. MegaBasic is packed in powder form and according to the instructions on how to use it, 20 gr of this powder should be dissolved in 250 ml water for each meal. Its caloric content is 3.664 kcal /gr and can be consumed up to 4 meals (80 gr) daily (The composition of the two energy drinks is shown in Table 1). Then, athletes performed the RAST test as in the first session, forty minutes after ingesting the beverages.

Table1. The contents of the two energy drinks

Substance	RDA %		Values in	
	MegaBasic	ORGAZMA	80 gr MegaBasic	100 ml ORGAZMA
Vit C	83.3		50 mg	
Vit E	66		6.6 mg	
Vit B1	78.6		1.1 mg	
Vit B3	33.3	44	6 mg	8 mg
Vit B5	50	33	3 mg	2 mg
Vit B6	52.6	100	1.05 mg	2 mg
Vit B2	56.2	38	0.9 µg	0.6 mg
Vit B7	33.3		50 µg	
Vit B9	75		150 µg	
Vit B12	150	200	1.5 µg	2 mg
Betacarotene	-		2 mg	
Fe	35.7		5 mg	
Zn	33.3		5 mg	
Mn	-		1.67 mg	
Na	-		517.21 mg	
P	29.3		233.01 mg	
Ca	25		200.28 mg	
K	-		149.83 mg	
Mg	20.8		62.42 mg	
Cu	-		669 µg	
Cr	-		60 µg	
Molybdenum	-		80 µg	
Se	-		30 µg	
Cl	-		636.36 µg	

Statistical Analysis: After the first session, the absence of any differences between the groups, all the measured variables (peak, min and mean powers, fatigue index, blood lactate levels in three phases and rate of perceived exertion), were tested using one way ANOVA. Also the homogeneity of all groups' variances for the measured variables was investigated. Then, in a second session, the pre and post-test data were analyzed with a paired sample t-test. An alpha level of .05 was used in determining statistical significance using the SPSS program for Windows, version 15.0.

3. RESULTS AND DISCUSSION

The mean values and standard deviations of all the measured variables of the three groups in the pre and post test are shown in Table 2.

Table 2. Descriptive Statistics (Mean, SD) for the measured variables of the three groups

Group	MegaBasic		ORGAZMA		Placebo	
Variables	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Peak Power (Watt/Kg.bw)	7.05±1.87	1.37±7.39	1.15±7.27	1.39±7.79	1.23±7.028	.35±7.61
Min Power (Watt/Kg.bw)	1.23±4.47	0.92 * ±4.71	0.71±4.54	0.82 ±5.04	0.562±4.65	0.24±4.94
Mean Power (Watt/Kg.bw)	1.34±5.72	0.9 *±6.01	1.19±5.58	1.21±6.13	1.17±5.86	1.41±6.12
Fatigue Index (watt/sec)	0.54±5.92	0.22±6.30	0.34 ±6.03	0.27±6.35	0.44±6	0.35±6.23
Pre lac (mmol/dl)	0.14±1.3	0.6±1.32	0.19±1.285	0.16±1.271	0.25±1.242	0.22±1.27
2 lac (mmol/dl)	0.82±8.242	0.88 *±8.48	2.05±9.128	1.14±8.8	1.33±8.885	1.439±9
6 lac (mmol/dl)	1.04±9.857	1.10±10.11	1.99±10.51	1.29±9.87	1.288±9.5	1.87±9.61
Mean RPE	20.6±1.64	16.9±1.91	20.8±1.73	17.5±1.87	20.1±1.94	17.8±1.85

*: There is a significant difference from the pre to the post-test

The analysis of the pre and post-test data by the pair-t-test showed that there were significant changes only in minimum power, mean power and the ORGAZMA group's lactate levels 2 minutes after the RAST test($p<0.05$).

The main findings of this study were that indices of anaerobic power, specifically Min and Mean power, and blood lactate levels two minutes after the RAST test in the ORGAZMA group were significantly enhanced by acute ingestion of this energy drink. Therefore, it is inferred that the acute ingestion of ORGAZMA prior to anaerobic exercise can have ergogenic effects.

Our results indicated that there was no change in any of the groups to the post-test peak power in comparison to the pre-test values. Peak power is defined as the calculated power from the best repetition of the RAST test (commonly the first or second repetition which in trained subjects usually lasts approximately between 4 to 5 seconds). It is well documented that peak power is considered an alactic power because of its short duration and it is unlikely that a glycolytic system can have a significant role in supplying its energy unless in the case that energy drinks would contain any compounds which can affect the Pcr system. By a simple insight into the compounds of these beverages (Table1), it appears that only the MegaBasic contains phosphorus. It is thought that phosphorus supplementation can improve an all out sprint performance by increasing the bufferic capacity (Tourville et al., 2001; MacDougall et al., 1991). On the other hand, the ORGAZMA drink contains Inositol which may have an ergolytic effect on anaerobic glycolysis (Tekin et al., 2004). Fry et al. (2006) also have reported no differences for peak power after supplementation with multivitamin mineral liquid. Therefore, our data can be considered to be in agreement with their results.

Another finding of this study showed that, in the subjects who had consumed the ORGAZMA drink, the post-test min power increased in comparison to the pre-test values, but that these changes were not significant in the placebo and MegaBasic groups. Min power is defined as the calculated power from the last repetition of the RAST test and Wingate test, respectively. It is well known that intermediate-term anaerobic tests (e.g., Wingate test), were designed primarily to assess lactic anaerobic power. The work rate at the end of these tests (e.g., during the last 5 s) can perhaps be considered as an indirect estimate of lactic anaerobic power output (Maud and Foster, 2006; MacDougall et al., 1991). Therefore, with respect to the high correlation reported between the RAST and Wingate tests (Zacharogiannis et al., 2004, Ghoudarzi, 2002), and with regard to the increased min power observed among the members of the ORGAZMA group, it is therefore inferred that the ORGAZMA energy drink could be effective in preventing fatigue onset until the last seconds of the RAST test. Therefore, it can be considered as an ergogenic drink under similar conditions. To the author's knowledge, no previous research has shown similar significant acute results.

In another part of our study, the post-test mean power, as was the case with min power, was increased in the ORGAZMA group, but these changes were not significant in the placebo and MegaBasic groups.

Mean power is defined as the average value of power output during six repetitions of the RAST test. Indeed, with increasing mean power, one can expect to perceive more exercise pressure and it seems that intramuscular lactate levels should be increased as well. With respect to the lower blood lactate levels observed two minutes after the RAST test, which reflects the intramuscular lactate levels during exercise, it can be suggested that the produced lactate in the muscles of the ORGAZMA group should be removed during the RAST test or during the time between the end of this test and blood sampling. It should be noted that blood lactate levels also were increased in both the placebo and MegaBasic groups when measured two minutes after the RAST test; nevertheless, these changes were not significant.

It is believed that the ingestion of alkalinizing agents can increase anaerobic performance (Stout, 2002; Bishop et al., 2004). It is also thought that the muscle membrane is impermeable to HCO_3^- and that only the extracellular compartments had an increased buffer capacity as a consequence of ingesting the alkalinizing agents. During repeated high-intensity exercise the alkalinizing influence of oral bufferic agents ingestion is, however, more successful because of the greater efflux of H^+ from the muscle that occurs during recovery intervals as a consequence of the increased buffer potential of the extracellular fluids (Maughan et al. 2002; MacDougall et al., 1991). It seems therefore that one mechanism accounting for the increased mean power and decreased blood lactate levels two minutes after the RAST test (in the ORGAZMA group) could be explained by the buffering content of this drink. Furthermore, it is believed that the effects of alkalinizing agents on improving a performance may be related to mechanisms other than the buffering capacity (Oo¨pik et al., 2003).

The unique finding in the present study was that there were no significant pre to post-test blood lactate changes in any of groups 6 minutes after exercise. It is possible that the ergogenic capacity of this energy drink is limited and transient in the case of acute administration. On the other hand, it has been previously shown that, there is a limited possibility of increasing body buffering stores (Maughan et al., 2002). Unfortunately we did not investigate the changes in blood pH, HCO_3^- concentration, and base excess. However, the dose of sodium citrate used (0.5 g/kg body mass) has been reported to be most appropriate for inducing the greatest increase in blood $HCO3^-$ concentration (McNaughton, 1990) and achieving an optimal alkalotic state 100–120 minutes after ingestion (Potteiger et al., 1996). Our subjects consumed a proprietary blend of ingredients (as an energy drink) 40 minutes prior to the RAST test. Therefore, in our protocol, the time period between the consumption of the beverages and the RAST test was not optimal and that the doses of sodium citrate were lower than the aforementioned value; therefore, further research is needed to clarify the mechanisms that are involved.

Another finding of this study was that the pre to post-test changes to the fatigue index in any group were not significant. The fatigue index is calculated as follows:

(Peak power – Min power) / total time of the RAST or Wingate test.

There is a lack of research concerning the effect of energy drinks on the fatigue index. In one study, Fry et al. (2006) noted a decreased rate of fatigue following multi-vitamin/mineral supplementation.

Certainly it is well known that minor values of the fatigue index can be considered as a smaller difference between peak and min power, in the event that total time is the same. In other words, it can be considered as an advantage. Nevertheless, in our study, the fatigue index was increased in all of the groups. Also, in our study the total time was decreased in all of the groups during the second session rather than the first one[2]. Therefore, it appears that there were no significant changes in the fatigue index because of a mathematical complication, so more research is needed in order for an eligible inference to be reached.

In another part of our study, we failed to detect any significant changes in pre-exercise blood lactate levels in any of the group. Few studies have focused on the effects of bufferic agents upon blood lactate levels and pH. Bishop et al. (2004) reported no effects of oral sodium bicarbonate ingestion on muscle resting pH and bufferic capacity in vivo. So our result can be considered to be in agreement with their findings. Very little is known about the mechanisms involved and further research is needed in this field.

Finally, the average rate of perceived exertion was decreased in all of the groups, but these changes were not significant. Crowe et al. (2006), Fry et al**.** (2006) and Sugiura et al. (1998) also reported that RPE can decrease with the ingestion of multi vitamin/mineral drinks or leucine supplementation. They implicated that this effect is possibly related to the compounds of these drinks such as caffeine, ginseng extract, glucuronolactone and others. Also, there was possibly learning and placebo effect.

Consequently it should be explained that one mechanism accounting for the unequal effects of these beverages in connection with anaerobic power and blood lactate levels,

[2] It can be inferred from the improvement of mean power in all of the groups.

can be explained by the differences in type and quantity of their constituents. Moreover, this study investigated the acute effects of energy drinks, and little is known about how much acute administration can increase muscle bufferic stores. Also, there was no information about the subjects' pre-exercise alkalotic state and more research, therefore, remains to be done in this important area.

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AKUTNI EFEKTI DVA ENERGETSKA NAPITKA NA ANEROBNU SNAGU I NIVOE LAKTATA U KRVI SPORTISTA

Karim Azali Alamdari, Mohammadreza Kordi, Siroosce Choobineh, Asghar Abbasi

U sadašnje vreme potrošnja dodataka i energetskih napitaka je veoma česta kod sportista. Međutim, postoje ograničena istraživanja u afirmisanju potrebe za konzumiranjem energetskih napitaka, pre i za vreme kratkog trajanja intenzivnih vežbanja. Takođe nema podataka o kvalitativnom rangiranju ovih produkata koji služe za odlaganje nastupa zamora i akumulacije laktata.

Cilj ovog istraživanja je bio da ispita akutne efekte dva energetska pića (ORGAZMA and MegaBasic) na anaerobnu snagu i nivoe laktata kod sportista.

Trideset dobro treniranih sportista studenata (starost: 22.34±1.74 godina, visina: 181.26±7.66 cm, težina: 76.37±6.85 kg i BF%: 13.2±2.7%) volontirali su i bili slučajno odabrani da učestvuju u ovom istraživanju.

Ovo istraživanje je bilo podeljeno na dve odvojene sesije, sa 4 dana odmora između istih. U prvoj sesiji, svi subjekti učestvovali su u RAST testu, posle standardnog doručka i njihovi nivoi laktata su mereni uzimanjem uzoraka krvi iz srednjeg prsta sa preporučenim laktomerom u tri faze {(1) pre početka testa, 2 i 3) dva i šest minuta posle odmora kada je test završen}. U drugoj sesiji, ispitanici su bili slučajno podeljeni u tri grupe (Placebo, OR and MegaBasic). Onda je svaka grupa primila 6 ml/kg.bw navedenih napitaka (četrdeset minuta pre testa RAST) odmah posle uzetog doručka. Nakon toga, ispitanici su testirani RAST testom drugi put. Naši rezultati pokazuju da u grupi OR, minimum i prosečna moć su bile povećane respektivno 11.01% i 9.15%, a nivo laktata koji je bio meren dva minuta posle RAST testa, bio je smanjen 3.63% ($p<0.05$).

Može se zaključiti da se ORGAZMA može smatrati ergogenetskim agensom, ali izgleda da je verovatno ergogenetski kapacitet ovog energetskog pića limitiran i kratkotrajan u slučaju stalne upotrebe.

Ključne reči*: energetski napitak, anaerobna snaga, krvni laktati, akutni efekti*