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THE EFFECT OF FRACTIONATED RED BEETROOT JUICE ON PERFORMANCE AND OVERALL HEALTH OF A HIGH-PERFORMANCE ATHLETES

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Abstract. *Over the past 20 years, nitric oxide has become the turning point in athlete physiology and medical research. It has been observed in scientific studies that there are very different protocols for the use of nitrates (red beetroot juice) and different research methodology and results. The most effective solutions for improving the performance of athletes are still being sought. The purpose of this research is to investigate the performance and overall health of a high-performance athlete after consuming fractionated red beetroot juice. The investigation is a one-case study. The respondent is a high-class athlete - track and field (middle and long distance), 20 years old. Three tests were performed in laboratory conditions with an interval of one week. The first test was without the use of fractionated red beetroot juice, the second test after a single dose, and the third after 7 days of use. The research used an interview of the respondent, cardio pulmonary exercise testing measuring device "Vyntus CPX" with gas analysis on a bike ergometer and determination of blood lactate concentration. In the experiment, the athlete's VO2max improved during each test, after one dose by 9%, and after 7 days of use by 13% from the first test. The physical overall health at the end of the test worsened each time, but in the previous tests, where fractionated red beetroot juice was used, a faster recovery of the athlete's working capacity after exercise was observed.*
Keywords: *endurance, nitric oxide, overall health, red beetroot juice.*

Introduction

In recent years, the trend among scientists is to study natural sports dietary supplements. A nutrient that has gained a lot of attention in recent years as a potentially performance-enhancing supplement for endurance in high-intensity athletes is dietary nitrate. According to the research data of the Anti-Doping

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Bureau of Latvia (2019 a), it was concluded that 36% of those surveyed, use various nutritional supplements to improve sports results, but in the study of the Anti-Doping Bureau of Latvia (2019 b), elite athletes more than half of the respondents bought and used supplements to improve sports results in the last year. It is crucial that sports nutritional supplements are not only able to improve athletic results, but are also safe for health. In addition, the International Olympic Committee included nitrates (NO3−) in the list of ergogenic agents for improving the performance of athletes (Maughan et al., 2018).

This explains the number of studies examining the effects of red beetroot juice during exercise on performance indicators (Mellentin, 2010; Larsen et al., 2011; Hoon et al., 2014; Jones, 2014; Thompson et al., 2015). In 2020, a systematic review was published on the effects of nitrate supplements on the performance of endurance sports. The study conducted a systematic literature review to investigate the use and effects of nitrate as a dietary supplement in endurance athletes who train in sports with repetitive movement. Although the systematic review analyzed a lot of data from published studies, researchers concluded that further research is needed to understand all the factors influencing the possible ergogenic effects of nitrates on the performance of endurance athletes (Calvo, Alarda-Capo, Pareja-Galeano, & Jimenez, 2020). Similar conclusions were reached by other researchers (Macuh & Knap, 2021), concluding that there is insufficient research on the effectiveness of nitrate supplementation in strength and high-intensity intermittent exercise.

In scientific studies, there are very different protocols for the use of nitrates, different research methodology and different results. The most effective solutions for improving the performance of athletes are still being sought. The ergogenic effect of red beetroot juice is associated not only with nitrates, but also with its other ingredients. To increase the specific efficiency of red beetroot juice, recently the original method of its fractionation on the basis of molecular mass by ultrafiltration was developed (Smirnova et al., 2022). The ergogenic effect of red beetroot juice is associated not only with nitrates, but also with its other ingredients. Fractionated red beetroot juice is a medium molecular fraction of juice obtained from a special variety of red beetroots. Its endurance-stimulating action is superior to native juice. It was concluded that the effect of a specific substance - fractionated red beetroot juice - on the performance of a high-achieving athlete after a single dose of 50ml and after a seven-day dose of 50ml, should be analysed.

One unique, high-class athlete - a track and field athlete (middle and long distances) was chosen as the basis of the study, for whom a full anamnesis was collected, including anthropometric data, health data, sports results, training and competition analysis. Tests were performed in laboratory conditions - ergometry with the cardiopulmonary measuring device "Vyntus CPX" with gas analysis on the exercise bike. After the laboratory experiment, data on the athlete's overall

health was collected, which supplements the statistical data of the study with the subjective opinion of the research participant.

The purpose of the analyse is to study the working capacity and overall health of a high-achieving athlete after consuming fractionated red beetroot juice.

Hypothesis: performance and overall health of a high-achieving athlete will improve after consuming fractionated red beetroot juice.

Previous Literature Reviews and Syntheses

Cyclic movements are often found both in human everyday life and in various sports. They can be characterized as actions performed that are constantly repeated and are directly related to the previous action in terms of their execution phases and structure. Cyclic movements are found in sports such as swimming, running, cycling, skiing and others. In cyclical sports, one of the main physical characteristics is endurance. High endurance scores are a prerequisite for achieving good results in all cyclical sports (Shave & Franco, 2006).

Some studies have found that after consuming an optimal dose of beetroot juice, both men and women (young and practically healthy) improved their performance by ~3%; ~6.2 mmol NO_3^-. Improvements in performance are observed within 2-3 hours after acute administration of 5-9 mmol (310-560 mg) NO3- (Hoon et al., 2014). Prolonged periods of NO_3^- intake (> 3 days) have been shown to be effective (Thompson et al., 2015) and may be a positive strategy for high-level athletes (Jones, 2014).

Researchers Macuh and Knap concluded that nitrates are an effective ergogenic aid for improving performance when administered acutely or chronically in the range of ~5-16.8 mmol (~300-1041 mg) (Macuh & Knap, 2021); in another systematic review: about 6–12.4 mmol/day of nitrate (Calvo et al., 2020).

Researchers agree that the nitrate dose should be administered 2-3 hours before activity (Calvo et al., 2020; Macuh & Knap, 2021; Hoon et al., 2014; Thompson et al., 2015; Jones, 2014; Kerksick et al., 2018).

Beetroot juice reduces muscle fatigue associated with high-intensity exercise, although it is unknown whether this is achieved by reducing fatigue and muscle damage and/or promoting muscle recovery after exercise (Dominguez et al., 2018).

Methodology

This study is part of a larger study "Effect of beetroot juice on the performance of athletes", in which three high-achieving athletes - swimmers and one high-achieving athlete - track and field athletes have been tested so far. This publication will analyse one case, a high-achieving athlete - a track and field

athlete. The experiment was conducted in accordance with the Declaration of Helsinki on human experimentation and was approved by the Ethics Committee of the Latvian Academy of Sports Education (LASE). The subject was fully informed about the course of the study, the product, possible risks, and additional benefits from the study and gave written consent to participate. Before participating in the study, the athlete underwent echocardiography and a resting ECG recording, and a sports doctor's opinion was obtained for permission to participate in this type of study.

Research base: LASE sports science research laboratory. Duration from October 11 to October 27, 2022.

The experimental protocol consisted of three tests performed on a cardiopulmonary measuring device "Vyntus CPX" with gas analysis. There was one week between all three tests. The subject was asked to refrain from any intense physical exercise for 36 h before each test, but to continue daily activities.

Fractionated red beetroot juice consumption and testing protocol in high performance athletes.

Test procedure: warm-up for 15-20 min (individual) and maximum oxygen uptake (VO2max) test on a bicycle ergometer until exhaustion. At the beginning of the test, there was a warm-up on the bicycle ergometer. The workload for the first five minutes was 24 Watt. Starting from the sixth minute, the workload was increased to 50 Watt and proportionally increased by 1 Watt every 10 seconds. Heart rate was continuously recorded during the test. During this session, VO2max consumption, maximal aerobic velocity and maximal heart rate were individually determined.

The second test took place a week after the first test. Before the test, the participant was asked not to chew gum or use mouthwash with menthol, so as not to affect the function of the nitrates. Two hours before the test, the study participant drank 50 ml of fractionated red beetroot juice with ~6.2 mmol NO3. Next, everything happened as in the first test: warm-up for 15-20 min (individually) and VO2max test on a bicycle ergometer until exhaustion. All the same measurements are being recorded.

After the second test day, the study participant consumed 50 ml of fractionated red beet juice with ~6.2 mmol NO3 every day and came to the test on the seventh day when he drank 50 ml of fractionated red beet juice with ~6.2 mmol NO3 two hours before the test. The third test was exactly the same as the first two tests with the same measurements.

After the tests, a structured interview took place, during which the athlete described how he felt before the tests, using fractionated red beetroot juice, during the tests, and during the recovery period.

The method of descriptive statistics was used for data processing using the Microsoft Office Excel program.

Research results

The participant of the experimental laboratory study was a high-achieving athlete - a track and field athlete. The athlete's age is 20 years, weight is between 67 and 69 kg, height 190 cm. The research participant has been playing sports since the age of 9, but not regularly. The main sport has been athletics, but also has participated in floorball and volleyball. The basic sport is athletics, mostly middle and long distances.

At the moment, participation is about 15 times per year. The competition seasons are between January to February and May to September, with approximately 2 competitions per month during this time. The current best achievement in sports Latvian Championship for adults is 2nd place in 1500m and 3rd place in 5000m.

During the study, the amount of training was reduced. The last competition was held on the 17th of September and a 6-week rest period was started for the body to recover. The trainings still take place every day, but the mileage was smaller (around 80km) and most of the kilometers were run in aerobic mode, one training session per week was a tempo run and the rest were easy runs. In addition to running, there was one general physical fitness training, one special physical fitness training for legs. The training loads before all the tests were the same, the tests took place during the rest period.

Before the study, the state of the participants health was appropriate for participation in the study, but before that, he notes overload in 2020, from an excessive amount of anaerobic loads and sleep disorders (problems falling asleep, but sleeps tight, about 7-8h). Heart rate at rest about 50 beats per minute, blood pressure 120/80 mm/Hg.

During the study, the diet did not change: 3 full meals a day, 1-2 snacks during the day. In total, about 3000 kcal. Vitamins C and D were additionally taken before the first test and during all tests.

1. test results and research participant's overall health

Prior to the first test, the study participant rated his physical fitness as mediocre because he had a cold a week before the test. Had slept for about 4 hours, because there was an additional workload in activities not related to sports. Also, the last 3 days before the test, there were problems falling asleep, which are related to the overload of intellectual work during this time.

The research participant described how he felt during the test, stressing that the first 15 minutes were easy to perform, but after that fatigue began to accumulate relatively quickly, although he felt quite good at the end and it seemed that he could definitely perform the test even longer. My legs felt strange because I had never done this type of test on an exercise bike before, and my glutes hurt because the seat was uncomfortable.

In the first test, the VO2max of the athlete was 54 mL min–1 kg, which according to the authors Ansley and Cangley is the level of prime performance (endurance) (Ansley & Cangley, 2009). The respiratory equivalent was 27 (VE/VO2), which is consistent with a high-performance athlete.

2. test results and research participant's overall health

Before the second test, the study participant rated his physical fitness as good. He had recovered, slept for 8 hours and had enough sleep several nights before the test.

Two hours before the test, the study participant drank 50 ml of fractionated red beetroot juice with ~6.2 mmol NO3.

Feeling during the test was similar to the 1st test. This time the first 20 min were very easy. The study participant noted that he felt much better than the first time, but this may be due to his health and sleep quality. After the test, he felt very tired, but it should be noted that the test lasted longer than the first time. His legs didn't hurt as much as after the first test and definitely recovered faster, because after the first test he still felt pain in the legs the next day.

In the second test, the VO2max of the athlete was 60.1 mL min–1 kg, reaching the second level of performance (endurance) according to the authors Ansley and Cangley. The respiratory equivalent was 34.5 (VE/VO2), which is 7.5 more than in the first test.

3. test results and research participant's overall health

After the second test day, the study participant consumed 50 ml of fractionated red beetroot juice with ~6.2 mmol NO3 every day and came to the test on the seventh day when he drank 50 ml of fractionated red beetroot juice with ~6.2 mmol NO3 two hours before the test. Before the third test, the study participant rated his physical fitness and well-being as very good, he did not feel tired, he noted a little pain in his legs, but it was from daily training.

The research participant emphasized that he felt physically exhausted during the test and was very close to maximum exhaustion. Especially the last 5 minutes of the test were the most difficult: it was very difficult to breathe and I felt a burning sensation in my legs.

After the test, it felt a little better than after the 2nd test, although the legs felt heavier. The research participant noted that he recovered relatively quickly after the third test, felt good already in the evening and did not feel like he had been tested to exhaustion. The next morning there was no physical fatigue and no pain.

The VO2max of the third test athlete was 62 mL min–1 kg, reaching the third level of performance (endurance) according to the authors Ansley and Cangley. The respiratory equivalent was 38.3 (VE/VO2), which is 11.3 more than in the

first test. The results show a high level of preparation of the athlete, but it is possible that the use of fractionated red beetroot juice improved this performance.

VO2max improved during each test, after one dose by 9% and after 7 days by 13% from the first test. The physical well-being at the end of the test worsened each time, but in the previous tests, where fractionated red beetroot juice was used, a faster recovery of the athlete's working capacity after exercise was noted.

In the first test, which was carried out without the use of fractionated red beetroot juice, a load of 301 Watt was reached in 43 minutes. In the second test, after a single consumption of fractionated red beetroot juice, 2.5 hours before the test, a load of 335 Watt was reached in 48 minutes and 26 seconds. In the third test, after consuming fractionated red beetroot juice for one week, receiving one dose daily, a load of 355 Watt was achieved in 51 minutes and 35 seconds (see Fig. 1).

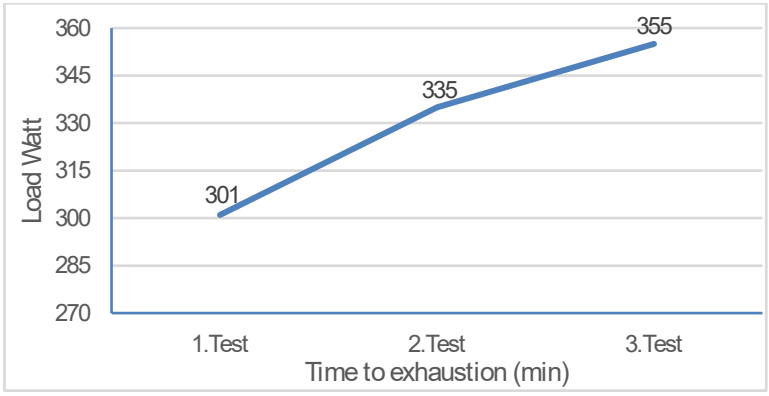

Figure 1 ***Time to reach maximum load (Watt) in each test*** *(created by the authors)*

The study participant concluded that when using fractionated red beetroot juice, he did not feel any difference in running training, but in physical training, especially in special training for the legs, he felt much better and did not feel tired the next day as he had before.

Conclusions

This study provides preliminary findings on the performance and overall health of a high-performance athlete after consuming fractionated red beetroot juice. It was concluded that a single dose of 50 ml of fractionated red beetroot juice with ~6.2 mmol NO3 improves VO2max by 9%, while using 50 ml of fractionated red beetroot juice with ~6.2 mmol NO3 for seven days improves VO2max by as much as 13%. The part of the hypothesis put forward by the authors, that the performance of a high-achieving athlete will improve after fractional consumption of red beetroot juice, has been confirmed. The findings show that fractionated red beetroot juice has a positive effect on the performance of high-performance athletes. How much of a role does the method of extracting

red beetroot juice play? Further research is needed to provide an accurate answer. Perhaps, the way of extracting red beetroot juice plays an important role in increasing the working capacity of athletes.

The second part of the hypothesis - the overall health of a high-achieving athlete will improve after fractional consumption of red beetroot juice is debatable. It was concluded that the athlete's overall health immediately after the maximum load test does not change significantly with or without the use of fractionated red beetroot juice. However, it is very important to note that after using fractionated red beetroot juice, the athlete states that he is able to recover faster, and his physical overall health returned faster. Using a fractional dose of red beetroot juice, a positive result was obtained in improving the athlete's performance, which provides the basis for further and wider research, increasing the number of respondents and obtaining statistically significant results.

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