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# ERGOGENIC DIETARY SUPPLEMENTS FOR OPTIMISED SPORTS PERFORMANCE

**Nikolai Latkov[1], Boisjoni Tohiriyon[2]*, Valerii Pozdniakovskii[3], Pastushkova Ekaterina Vladimirovna[2], Valentina Lapina[2]**

1. ***Department of Technological Entrepreneurship, Kuzbass State Agricultural Academy, Kemerovo, Russia.***
2. ***Department of Management, Entrepreneurship, and Engineering, Ural State University of Economics, Ekaterinburg, Russia.***
3. ***Scientific and Educational Center for Applied Biotechnology and Nutrition, Kemerovo State Medical University, Kemerovo, Russia.***

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**ABSTRACT**

The present study discusses the chemical composition, safety, and efficacy of a dietary supplement with pantohematogen, which is made from the blood of the Altai wapiti. The research methodology focuses on studying the effectiveness of the supplement by assessing the influence of its active ingredients on sports performance. The clinical study targeted professional rowers and mountaineers, whose high-intensity and prolonged training require carefully designed nutrition plans. Pantohematogen demonstrated its effectiveness resulting in improved blood biochemical composition, increased speed, and enhanced performance of rowers; while the positive impact made on mountaineers included better adaptation to high altitude, improved working memory, and better mental and physical capacity. To check compliance with the anti-doping regulations, anti-doping tests were taken and the results were negative. The findings indicate that dietary supplements with pantohematogen can successfully assist in maintaining the proper functioning of the nervous, immune, and cardiovascular systems when included in the nutrition plans of professional athletes.



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## Introduction

Since sports are becoming more intensive and competitive with heightened pressure to succeed, several important issues need to be addressed, such as effective adjustment and adaptation to training programs, consistent enhanced performance at training and competitions, faster recovery, reduced risk of overstrain or injuries, and straightened immune system and health maintenance. Today, professional athletes are increasingly aware of the advantages of carefully designed nutrition plans, and thus, sports nutrition has become one of the most dynamic sports sciences. For decades, many researchers have explored the potential of including functional foods in the nutrition plans of high-performance athletes in order to meet challenging nutritional goals and optimize competition performance. The influence of an increased intake of macro- and micro-nutrients when training was studied [1, 2] and international practices were compared [3]. Foods of plant, animal, or mineral origin with documented beneficial effects have been used to boost metabolism and body functions, and prevent and treat infectious and non-infectious diseases [4-12]. Existing research conducted by Russian scientists demonstrated that antler products, including pantohematogen, can be successfully added to the diets of professional athletes to respond to their nutritional needs during training, competition, and recovery periods [13, 14]. It should also be noted that while developing nutrition plans, different factors like individual physique, age, lifestyle, and intensity have to be taken into account [15-17].

Latterly, many scientists have explored the impact of proper nutrition on maximizing performance and accelerating post-exercise recovery [18, 19]. Acknowledging the significance of further research, we aimed to explore a dietary supplement containing pantohematogen and assess its efficacy in improving athletic performance.

**Corresponding Author:** Boisjoni Tohiriyon; Department of Management, Entrepreneurship, and Engineering, Ural State University of Economics, Ekaterinburg, Russia. E-mail: tohiriyoni@gmail.com.

## Materials and Methods

The authors aimed to study the chemical composition and evaluate the quality, safety, and efficacy of 'The Ergopan' dietary supplement. The main ingredient of 'The Ergopan' dietary supplement is pantohematogen. To produce pantohematogen, fresh blood of the Altai wapiti is turned into powder by dehydrating and grinding. As the final product must be of high purity, safety, stability, and functional activity, the temperature during the production stage does not exceed 40°C. For our study, we performed doping tests on both the dietary supplement and the athletes. Samples of urine were analyzed for banned substances like stimulants, narcotics, peptide hormones, β-blockers, steroids, and local anesthetics using gas chromatography, chromato-mass spectrometry, and enzyme immunoassay tests.

The first clinical trial included twelve professional rowers, eight men, and four women, aged 21-34. The participants, all with recognized awards like Masters of Sports, Masters of Sports of International Class, and Honoured Masters of Sports and sporting experience of 7-19 years, were divided into two groups: the first (main) group and the second (control) group of six participants each (four men and two women). For the three weeks at the training camp, the participants shared equal nutrition, training load, and recovery and were under constant medical supervision. The participants of the first (main) group received 0.4 g of pantohematogen twice daily before meals for fourteen days, while the participants of the second (control) group received a placebo (potassium orotate) twice daily for the same period.

According to the protocol of the clinical study, before, during, and after the trial, the participants were tested for changes in speed and functioning using the step-wise incremental load test performed on the Gjessing rowing ergometer. At the same time, changes in lactic acid in the peripheral blood, blood pressure, heart rate, heart rhythm, and body composition were carefully recorded. Self-assessment of general well-being was carried out with the help of questionnaires.

The second clinical trial was aimed at studying the efficacy of the dietary supplement when taken by mountaineers. The participants were tested before their departure to the training camp in Ala-Archa Park (an alpine national park in Kyrgyzstan) and after a week-long high-altitude training at 3,500 meters above sea level.

## Results and Discussion

The chemical composition of pantohematogen was analyzed at the laboratory complex of Tomsk National Research Medical Centre of the Russian Academy of Sciences **(Table 1)**.

**Table 1.** The chemical composition of pantohematogen

| | Nutrient | Content, g/100g |
|---|---|---|
| Amino acids | Lysine | 0.9 |
| | Histidine | 0.35 |
| | Arginine | 1.13 |
| | 4-oxoproline | 0.95 |
| | Tryptophan | 1.26 |
| | Threonine | 0.57 |
| | Serine | 0.68 |
| | Glutamine | 1.6 |
| | Proline | 1.27 |
| | Glycine | 2.2 |
| | Alanine | 1.38 |
| | Cystine | 0.04 |
| | Valine | 0.64 |
| | Methionine | 0.1 |
| | Isoleucine | 0.24 |
| | Leucine | 1.15 |
| | Tyrosine | 0.24 |
| | Sarcosine | 1.16 |
| | Taurine | 0.03 |
| Lipids | Free fatty acids | 0.56 |
| | Phospholipids | 2.42 |
| | Triglycerides | 0.51 |
| | Sphingomyelin | 0.179 |
| | Isolecithin | 0.143 |

| | | |
|---|---|---|
| | Lecithin | 0.233 |
| | Colamine-cephalin | 0.358 |
| | Cerebroside | 0.483 |
| | Cardiolipin | 0.555 |
| Macro and micronutrients | Calcium | 0.15 |
| | Magnesium | 74 |
| | Aluminum | 27 |
| | Iron | 360 |
| | Silicon | 28 |
| | Phosphorus | 120 |
| | Sodium | 900 |
| | Potassium | 120 |
| | Copper | 0.1 |
| | Iodine | 0.08 |
| | Manganese | 34 |
| | Tin | 3 |
| | Barium | 6.4 |
| | Cobalt | 0.05 |
| | Vanadium | 0.04 |
| | Hypoxanthine | 44.2 |
| | Uracil | 39.1 |

As can be seen from **Table 1**, pantohematogen contains a wide range of biologically active compounds which are vital for proper functioning and general well-being [20-22]. Therefore, pantohematogen can be considered an adaptogen and can be added to diets to improve performance, build resilience, and help maintain normal body functioning while competing. Besides, pantohematogen can be added to vitamin supplements to boost their nutritional value. The ingredients of dietary supplements include pantohematogen, ascorbic acid, and glucose which produce a combined effect **(Table 2)**.

**Table 2.** The ingredients of dietary supplement

| **Ingredients** | **Content, g/capsule** |
|---|---|
| Dry pantohematogen | 0.025 |
| Ascorbic acid | 0.005 |
| Glucose | 0.170 |

Previous studies of pantohematogen have emphasized the benefits of adding it to the nutrition plans of professional sportsmen for several reasons [13, 23, 24]. First, it improves oxygen metabolism and appropriate oxygen supply to muscles and maintains proper metabolic reactions which are essential for optimal performance, endurance, and aerobic power. Second, it helps to reduce the build-up of lactic acid. With improved oxygen metabolism, energy is produced through aerobic respiration, thus less lactic acid is built up, and, as a consequence, muscles are less sore after strenuous exercise. Third, it assists in maintaining appropriate muscle glycogen levels in the liver, heart, and muscles. Consumption of pantohematogen supplements helps replenish muscle glycogen after intensive exercises as well as quickens recovery. Finally, it promotes stress management. As competitions are extremely stressful situations, dietary supplements with pantoheatogen help combat nerves.

It should be highlighted that dietary supplements can be consumed by people doing recreational sports, especially those who take up sports following medical advice. These people often suffer from obesity or other related diseases, poor cardiovascular system, and their mobilization is low [25-27]. The dietary supplement improves mobilization, lessens the strain on the cardiovascular system, and assists in converting fats into energy. Seemingly, energy metabolism is very important for people doing sports to lose weight.

Another significant factor, which should be taken into account, is dehydration. Electrolyte imbalance impairs the sports performance and body functioning of many professional athletes with their high-intensity and prolonged training [4, 21]. When considering electrolyte imbalance, the reasons for the improper functioning of ion pumps, which pump ions into and out of cells producing the concentration gradient in cells and tissues, should be noted. The main regulators of the sodium-potassium pump activity are hormones produced by the pituitary and adrenal glands (aldosterone, glucocorticoids, mineralocorticoids). Pantohematogen increases the activity of the pituitary-adrenal system, and therefore, provides for the appropriate functioning of the pumps [13].

Certainly, reparative processes are an important aspect to consider. Regular moderate exercise activity strengthens the musculoskeletal system and improves body functions as well as the quality of life [14, 15]. While strenuous training can

increase the risk of injuries as well as affect the heart and arteries. To repair the damage caused by vigorous exercise activity, it is necessary to initiate and stimulate the reparative process. For example, the loss of mineral content of bones makes bones more fragile and many sportsmen aged 40 or older suffer from various age-related conditions [20, 21, 23]. Pantohematogen enhances bone tissue growth and improves recovery by assisting in repairing damage and boosting body adaptation to stress.
Professional athletes, whose training sessions are usually long and intense, are susceptible to an increased risk of infection since they are predisposed to common illnesses caused by variations in cellular components and soluble factors of the immune system. Pantohematogen enhances immunity by reinforcing phagocytosis [13].
To assess the efficacy and functional properties of the dietary supplement as well as compliance with anti-doping regulations, tests were conducted at the anti-doping laboratory of the All-Russian Scientific Research Institute of Physical Culture and Sports. No prohibited or conditional substances were found in samples of the dietary supplement. All urine tests were also negative.
The clinical trial findings of the impact of pantohematogen on sports performance of professional rowers are presented in **Figure 1**. When taken for the two-week period, the dietary supplement contributed to the reduction of time necessary for performing fixed stages of step-wise incremental load test, while decreasing the concentration of lactate in the peripheral blood. With the blood lactate levels of 2, 4 and 6 mmol/L, the increase in speed for the participants of the first (main) group amounted to 14.3, 7.2 and 4.5 cm/s ($P<0.05$) respectively. With the blood lactate level of 8 mmol/L, there was lack of statistical significance. While the participants of the second (control) group demonstrated the increase in speed at the blood lactate levels of 2 and 4 mmol/L (13.1 and 5.3 cm/s). With higher blood lactate levels of 9.6 and 8 mmol/L, a noticeable decrease in speed was registered ($P<0.05$).

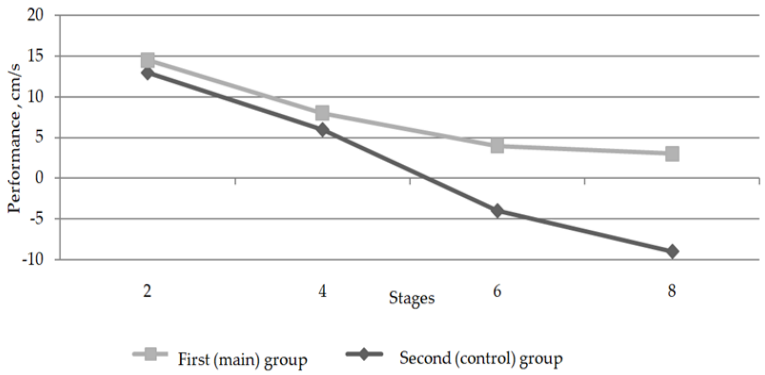


**Figure 1.** The impact of pantohematogen on the sports performance of professional rowers

As a result, the participants whose nutrition plans included pantohematogen were able to increase speed even with blood lactate levels of 6 and 8 mmol/L, while the participants from the control group demonstrated poorer performance at the blood lactate level of 6 mmol/L. When compared, the results of the initial and repeated step-wise incremental load testing indicate the decreased blood lactate level. Statistical significance of the decreased blood lactate level at the first and third stages of the test amounted to 33 and 9 % ($P<0.05$), with a downward trend at other stages. In the meantime, no statistically significant decrease in the blood lactate level was registered when the repeated tests of the participants from the control were conducted. This led us to conclude, that a two-week course with the dietary supplement improves blood biochemical indicators, and assists in increasing the speed at fixed periods, together with enhanced performance at lower energy expenditure. The impact of the dietary supplement on body composition is shown in **Tables 3 and 4**. As the clinical trial was performed at the training camp, the participants were mainly engaged in glycolytic training.

**Table 3.** The main group of rowers: changes in body composition

| | **Initial testing** | | **Repeated testing** | |
|---|---|---|---|---|
| | **Weight (kg)** | **Muscle mass/ Fat mass (%)** | **Weight (kg)** | **Muscle mass/ Fat mass (%)** |
| 1 | 82.0 | 55.2/9.7 | 81.8 | 55.4/9.1 |
| 2 | 80.1 | 53.9/11.4 | 80.4 | 54.0/11.3 |
| 3 | 76.4 | 55.9/8.6 | 76.9 | 55.6/8.8 |
| 4 | 79.3 | 51.4/7.9 | 79.3 | 51.2/7.5 |
| 5 | 76.2 | 49.8/13.3 | 76.9 | 51.0/13.0 |
| 6 | 75.2 | 52.0/11.8 | 74.3 | 52.9/10.9 |
| | | Average | | |
| | 78.13 | 53.12/10.45 | 78.3 | 53.28/10.05 |

**Table 4.** Control group of rowers: changes in body composition

| | Initial testing | | Repeated testing | |
|---|---|---|---|---|
| | **Weight (kg)** | **Muscle mass/ Fat mass (%)** | | **Weight (kg)** |
| 1 | 84.3 | 56.5/9.9 | 84.0 | 55.9/9.4 |
| 2 | 85.1 | 54./10.8 | 84.6 | 53.7/10.2 |
| 3 | 79.4 | 52.5/8.5 | 79.2 | 52.0/8.8 |
| 4 | 73.8 | 55.9/8.9 | 73.4 | 55.2/8.5 |
| 5 | 71.7 | 52.1/12.8 | 72.0 | 51.7/12.9 |
| 6 | 76.6 | 53.9/10.8 | 76.5 | 54.0/11.4 |
| | | Average | | |
| | 78.48 | 54.18/10.18 | 78.28 | 53.7/10.26 |

Comparing the data on the body composition of the participants of the main group, it is clear that, in general, with muscle mass retained, there was a decrease in fat mass. This fact allows us to conclude that pantohematogen assists in maintaining muscle mass and burning body fat as muscle fuel. It should also be noted that when the data on body composition is compared with the data on performance, better muscle adaptation to training can be observed.

The testing results correlate with the results collected from self-assessment questionnaires. All rowers from the main group highlighted good exercise capacity, readiness for training, good sleep, and appetite. While three rowers from the control group mentioned irregular sleep and increased fatigue by the end of the training period. Medical monitoring undertaken during the clinical trial did not indicate any significant anomalous patterns, with the exception of the signs of overstrain that were present in the myocardium of two rowers from the control group. No side effects were registered by either medical monitoring or self-assessment.

The findings of the trial demonstrate that the use of the dietary supplement in the nutrition plans of professional athletes leads to enhanced performance, builds up endurance, and assists in shifting the blood lactate curve to the right while maintaining muscle adaptation to training. The results of the study confirmed that pantohematogen can be added to the nutrition plans of professional athletes in the pre-competition phase to optimize performance.

In the case of the mountaineers, the participants of the main group were prescribed the dietary supplement to be taken for one week, while the participants of the control group were given a placebo (glucose mixed with cacao powder). The positive changes observed during the trial included improved working memory, reduced tension of the regulatory systems, and enhanced physical activity. After the exercise, in 48% of the cases, the mountaineers from the control group experienced higher or lower blood pressure (when compared to their regular blood pressure), whereas the participants of the main group suffered from blood pressure changes only in 2% of the cases.

The results of the Shtange test (a breath-holding test) were found interesting. During the adaptation, a reduction in the length of time the athletes could hold their breath was registered, more noticeable among the athletes from the main group. It might sound contradictory; however, the Shtange test is designed to reflect carbon dioxide concentration, not the lack of oxygen.

At high altitudes, the body experiences not only a lack of oxygen but also excessively loses carbon dioxide which, in turn, causes disruptions in respiration. That is the reason why the reduction in the breath-holding time registered during the Shtange test indicates the adaptation of the respiratory system to high altitudes. Therefore, pantohematogen improves respiratory adaptation. The impact dietary supplement made on mountaineers is presented in **Figure 2**.

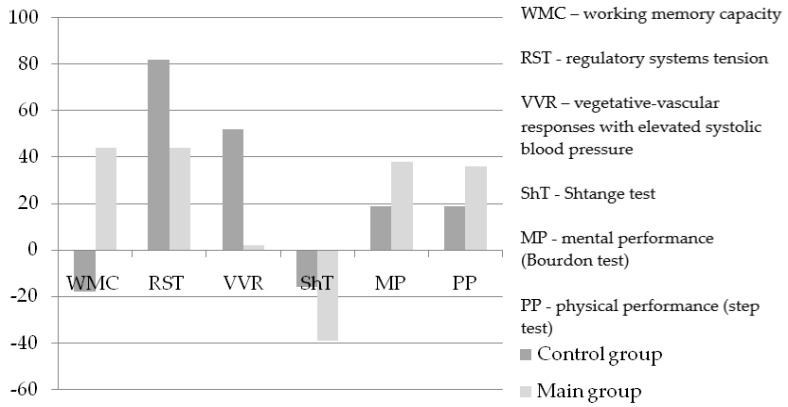


**Figure 2.** The impact of a dietary supplement on mountaineers

The findings of the tests revealed that pantohematogen can soften the transition between physical activity and rest. As training is usually effortful, failing to rest can degrade the regulatory systems, and cause tension and fatigue. With the help of

pantohematogen, the participants of the main group were able to maintain the right balance between high-intensity training and the right amount of rest, with cognitive fatigue reduced and energy replenished.
As indicated previously, the dietary supplement includes Vitamin C, which is necessary for physiologically important processes like collagen synthesis and adrenal hormone production (adrenaline and corticosteroids). Participating in metabolic processes, vitamin C inhibits oxidative damage, increases endurance, and accelerates recovery and tissue regeneration [4, 21]. The findings of our study together with the previous research suggest that pantohematogen is effective in optimizing sporting performance, enhancing muscle performance, and improving the functioning of the nervous and cardiovascular systems. Professional athletes are recommended to take 6-8 capsules twice daily (in the morning and the afternoon before meals).
Although there are several studies of pantohematogen, some questions regarding the production and the use of dietary supplements with pantohematogen are yet to be explored.

**Conclusion**

The study findings contribute to our understanding of pantohematogen and provide a basis for further research and application. As with the majority of studies, our trial has certain limitations that could be addressed in future research. First, the sample size was small. Second, the participants selected for the trial were limited to rowers and mountaineers. Therefore, these limitations should be taken into account when interpreting the results of our study.
We recommend including a dietary supplement in the nutrition plans of professional athletes who perform high-intensity and prolonged training in order to enhance performance, build up endurance, and maintain proper functioning of the nervous, immune and cardiovascular systems.

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**Conflict of interest:** None

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**Ethics statement:** All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

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