



Article

Evaluation of The Effectiveness of A Combination of Pharmacological Substances For The Purpose of Improving Adaptation and Increasing Physical Endurance to Intensive Physical Activity

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Abstract: The last 10-15 years have been characterized by the introduction into sports practice of a huge number of pharmacological preparations used with the general goal of increasing the general and special physical performance of athletes and accelerating recovery. Sports pharmacology, as a branch of sports medicine, currently represents a fully formed and rapidly developing direction of the so-called "pharmacology of a healthy person", the tasks of which are the correction of the functional state of the body of a healthy person in complicated (extreme) operating conditions. The article presents data obtained as a result of an experimental study of a new combination of known pharmacological substances permitted for use in terms of anti-doping legislation to improve the adaptive and restorative capabilities of the body.

Keywords: adaptation to physical activity, arginine, levocarnitine, lysine, pharmacological correction, sports activity, sports pharmacology, succinic acid, zinc sulfate

1. Introduction

Today, there is a enormous variety of pharmaceutical products promoted as specific professional means for accelerating the body's recovery after intense physical activity, improving sports performance, and preventing injuries. Also, the ever-growing competition is the reality of modern high-performance sports, which imposes increasingly complex requirements on the construction of educational and training processes and methods, as well as on the methods of restoring the body after training and competitive loads. But it is worth noting that a large number of pharmaceuticals that are freely available are included in the list of prohibited drugs of the International Anti-Doping Agency (WADA). In this regard, sports pharmacology plays an important role in the fight against illegal substances in the pharmacotherapy of high-performance sports, as well as in identifying and preventing the possible development of negative effects, drug interactions and any other problems associated with the use of various pharmacological substances.

Therefore, the main task of sports pharmacology and pharmacy in general is to create such combined substances that will affect both energy metabolism and muscle metabolism of the body. In this case, it should be taken into account that to achieve a pronounced effect, an increase in the dosage of individual components is required, and this in turn proportionally increases the risk of developing side effects of combined medicinal substances. In this regard, the development and use of non-doping means of

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pharmacological correction is more relevant than ever, since it allows you to activate and reduce the time of adaptation reactions of the body to progressively increasing loads.

Aim of the work

To study and evaluate the effectiveness of a new combination of medicinal substances based on levocarnitine, with the aim of improving performance, adaptation to physical activity and increasing efficiency in sports activities.

2. Materials and Methods

The study of acute toxicity and the experimental combination of substances was conducted in the laboratory of Pharmaceutical Education and Research. Acute toxicity and the main experimental part were consisted of three stages. The experiment as a whole was carried out for 4 months, including the preparation of reporting and analytical documentation.

To simulate various physical loads and to assess the muscle strength of experimental animals, the following models were selected: treadmill test, "grip strength", forced swimming test (Porsolt test).

According to the study design, 75 white, non-linear, sexually mature male rats of approximately the same age (average weight 200 ± 20 g) were selected, marked and sent to a 10-day quarantine with free access to water and food.

Acute toxicity of the drugs was studied on 30 white mice, weighing 19-21 g, mixed sex. The animals were under continuous observation for the first hour, then under hourly observation during the first day of the experiment and once a day during the following 13 days of the experiment. The following were taken into account as indicators of the functional state of the animals: the general condition of the mice and their behavior, the intensity and nature of motor activity, the presence of convulsions, coordination of movements, response to external stimuli and skeletal muscle tone, frequency and depth of respiratory movements, color of the mucous membranes and pupil size, appetite, body weight, amount and consistency of feces. During the experiment, the clinical condition of the animals was monitored: the presence/absence of signs of poisoning, the time of their appearance, the death of the mice.

3. Results

To solve the problem, it was necessary to develop a composition that, combining minimal concentrations of active substances, would provide results superior to known analogues, including by enhancing the adaptive capabilities of the body, accelerating recovery processes and reducing the degree of fatigue after intense physical activity.

The studied combination of known components in strictly defined qualitative and quantitative ratios (L-carnitine, L-arginine, L-lysine, zinc sulfate, succinic acid) provides a synergistic effect aimed at increasing physical endurance, improving the body's adaptation to intense physical activity and accelerating recovery processes after training. This combination of components allows us to solve the problem, expanding the range of effective pharmaceutical combinations for use in professional sports.

When the substance was administered at a dose of 4000 mg / kg, mice became lethargic and inactive, then the condition of the animals returned to normal. In this group, 2 mice died. When the substance was administered at a dose of 5000 mg/kg, the experimental animals showed increased respiratory rate, decreased motor activity, impaired coordination, weakened response to external stimuli, and decreased food and water consumption. Four mice died in the drug group. When a dose of 6000 mg/kg was administered, the animals assumed a lateral position and did not respond to external stimuli. Five mice died in this group during the first day of the experiment.

Administration of a dose of 8000 mg/kg caused total death of the animals immediately after administration of the substance.

The condition of the surviving animals by the end of the experiment normalized as the signs of intoxication decreased. LD50 of the substance was 4536.4 (3947.1 ÷ 5126.6) mg/kg. Thus, the obtained data show that the LD50 of the experimental combination was 4536.4 (3947.1 ÷ 5126.6) mg/kg and the complex is classified as a low-toxic substance (class IV).

The animals' performance in the treadmill test was tested on the 7th day of the experiment, as well as on the 14th and 21st days of the experiment. Throughout the experiment, the angle of the tape relative to the ground plane was 15°, the speed was 12 m/min. Throughout the experiment, the duration of running until signs of fatigue appeared was recorded (Figure 1).

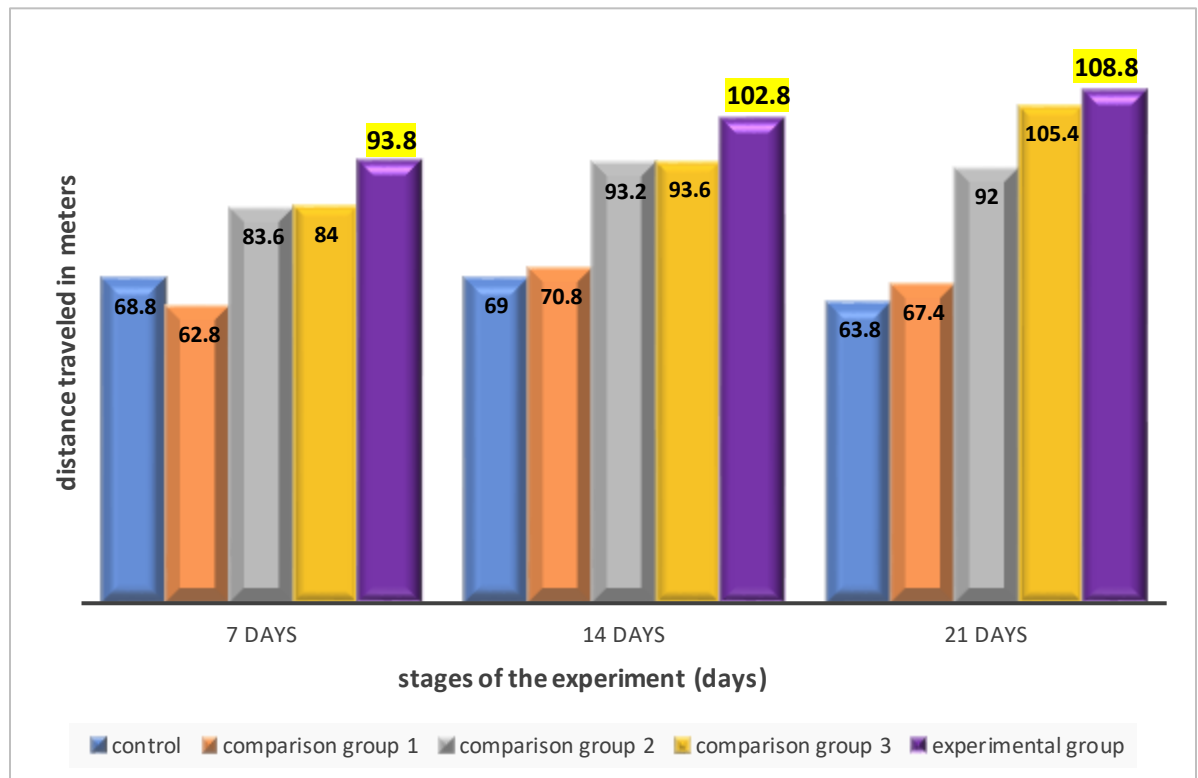


Figure 1. Results of the treadmill test study

The introduction of the complex for 21 days at a dose of 200 mg / kg increased the physical endurance of rodents, extending the running time by 39.4% compared to the rats of the control group. In comparison with the experimental group taking succinic acid, the running time increased by 36%, with the experimental group taking zinc - by 12.7%, and by 11.5% increased, compared to the experimental group that took levocarnitine (Figure 1).

To assess the swimming time, we used a container made of organic glass, according to the classical Porsolt method, with a water temperature of 24-28 degrees. We assessed the swimming time to failure, recorded during control tests in the dynamics of observation (Figure 2). Administration of the complex for 14 days at a dose of 200 mg/kg increased the physical activity of mice, extending the time of swimming with a load by 160% compared to the rats of the control group. Administration of the complex for 21 days at a dose of 200 mg/kg increased the physical activity of mice, extending the time of swimming with a load by 226% compared to the rats of the control group. Daily administration of the combination of substances to laboratory animals for 21 days increased their performance and endurance in the forced swimming test with a load. The time the animals spent on the surface of the water increased continuously throughout the experiment and reached its maximum value on the 21st day of the experiment.

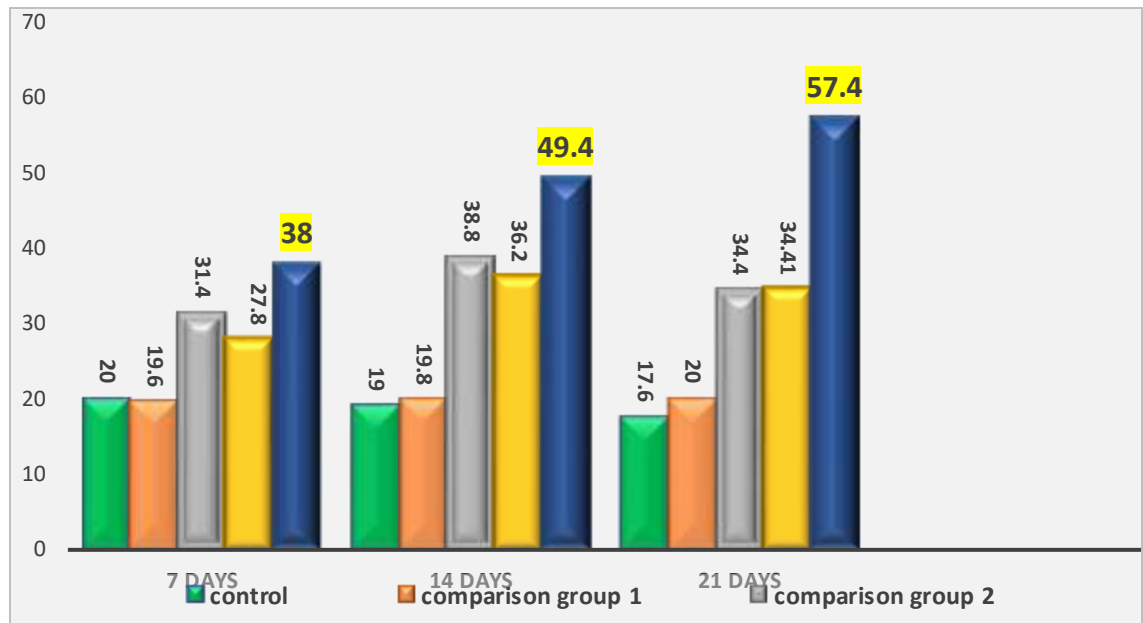


Figure 2. Results of the study of adaptive and restorative capabilities and performance according to the Porlsolt test

The evaluation of the obtained results was carried out in a comparative aspect between the study groups. Based on the processing and evaluation of the obtained data, an assessment of the effectiveness of the claimed combination of medicinal substances was given.

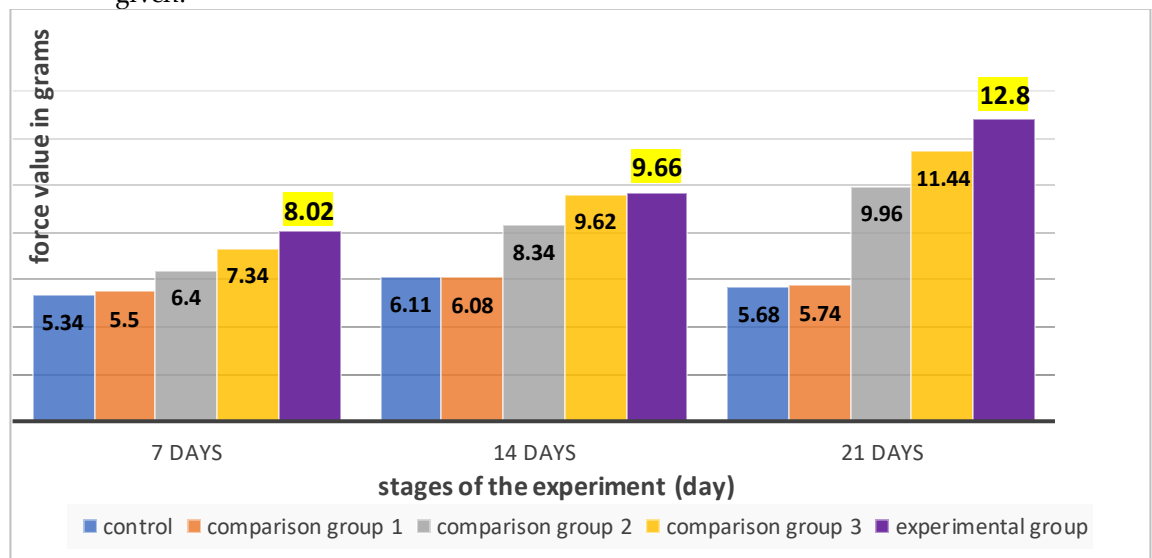


Figure 3. Results of the study on the grip strength test

The grip strength test is an ideal supplement for studying the coordination of movements and motor functions. It allows to evaluate the effect of drugs, toxins, muscle relaxants, diseases, age-related changes and neurological disorders on muscle strength. When testing on the 7th day of introducing the complex, an increase in muscle compression strength by 33.4% was noted compared to the control group. Compared to the experimental group taking succinic acid, the paw compression strength increased by 31.4%, with the experimental group taking zinc - by 20.1%, with the experimental group taking levocarnitine - by 8.4%. (Fig. 3)

A comparison of the obtained results, shown in these graphs, shows a change in performance in the direction of increasing the duration of swimming, running duration and in the "grip strength" test in the experimental groups in contrast to the control group and comparison groups, which undoubtedly proves the effectiveness of the impact of the experimental complex on the level of adaptation and recovery reactions, on physical activity and increased performance.

4. Discussion

The study demonstrated that the combination of L-carnitine, L-arginine, L-lysine, zinc sulfate, and succinic acid significantly enhances physical endurance, adaptation, and recovery processes after intensive physical activity. The results indicate that this combination produces a synergistic effect, improving performance in treadmill tests, grip strength, and forced swimming tests in experimental animals. Notably, the administration of the complex for 21 days at a dose of 200 mg/kg resulted in a substantial increase in physical endurance, with running duration extended by 39.4% and swimming time increased by 226% compared to the control group. Furthermore, the toxicity assessment classified the substance as low-toxic (Class IV), suggesting its safety within the tested dosage range. These findings suggest that this pharmacological combination may serve as a promising, non-doping approach to enhancing athletic performance and recovery. However, further studies, including clinical trials on human subjects, are necessary to validate these effects and determine optimal dosage strategies for practical application in sports medicine.

5. Conclusion

Thus, when studying the physiological parameters of rodents, when introducing an experimental combination of substances, a more positive effect on the rats' organism is observed than with separate administration of these compounds. The obtained results should be taken into account when developing approaches to complex use when drawing up nutritional and metabolic support programs to improve physical performance, as well as adaptation to physical stress, mental stability and the body's ability to quickly restore resources after extreme training and competitive loads. This complex has a more pronounced stimulating effect on the physical performance of animals, increasing animal endurance and preventing the development of fatigue.

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