Scholar Publishing Group
International Journal of Sports Technology
https://doi.org/10.38007/IJST.2022.030102
ISSN 2789-7141 Vol. 3, Issue 1: 14-25

Vitamin C Spirulina Mixture to Improve Sports Endurance

Eleni Theodoraki*

Edinburgh Napier University, UK

**corresponding author*

Keywords: Vitamin C, Exercise Endurance, Spirulina, Exercise Fatigue

Abstract: To explore the effect of vitamin C Spirulina mixture on improving sports endurance. 80 male rats aged 8 weeks were selected. All the rats were fed with basic diet and boiled water, and they could eat freely. They were randomly divided into 8 groups with 10 mice in each group: quiet control group A, VC group B, spirulina group C, VC Spirulina mixture Group D. the mice in each group were fed regularly according to the experimental design, and the control group was given intragastric administration of normal saline. After the weight-bearing swimming experiment, the general condition of mice and the detection indexes of Hb, LD, CK and BUN were observed. The data were statistically analyzed by logical analysis. In the weight comparison, the weight of mice in each group increased normally and grew well during the whole experiment. Compared with the experimental group, the weight gain of quiet group was faster, but there was no significant difference ($P > 0.05$). There was significant difference between group C of Spirulina mixture and group D of VC Spirulina mixture ($P < 0.05$), and the delay rate of depletion time was 34.47% and 20.07%, respectively; there was also significant difference between group D of VC Spirulina mixture and group C of Spirulina ($P < 0.05$). There was a significant difference between the spirulina mixture group and the control group ($P < 0.05$). The serum CK activity was lower in all resting groups. There was no significant difference between VC group B and quiet control group A ($P > 0.05$). There was significant difference between group C of Spirulina mixture and group D of VC Spirulina mixture ($P < 0.05$). Vitamin C Spirulina mixture can inhibit the decrease of Hb content, improve the ability of aerobic metabolism and delay the occurrence of exercise-induced fatigue.

1. Research Background

Exercise endurance, it can improve the activity of antioxidant enzymes [1-2]. In addition, it can eliminate excessive free radicals, so as to improve the self immunity [3-5]. In general, if the

production and release of free radicals in the body are equal to each other, because of some physical or chemical factors, the balance state will be broken, then more free radicals will be generated, which will lead to further cell damage [6-8]. Therefore, it plays an important role in biology and human body, and under certain conditions, it can also become a toxin to attack the human body [9-10].

It can be used as medicine and adjuvant medicine to treat a variety of diseases. Its functions include: enhance the body's immunity, slow down the aging rate of cells, reduce cholesterol, and have anti-cancer and anti-cancer effects [11-12]. From spirulina, which extracts polysaccharides from the body, it can then explore whether it can improve the endurance of mice. By stimulating the synthesis of prostaglandins, we can then regulate the body's physiological function, promote metabolism, and make our collective get further immunity. It has good curative effect on anemia, hepatitis, diabetes, gastroduodenal ulcer, vision decline, liver disease and so on. It can also be used for the rehabilitation of patients with severe malnutrition and the rehabilitation of the weak after the disease. It has a special effect on the nutrition of children, the health care of the elderly and the extension of life. Its mechanism is to enhance the proliferation of bone marrow cells, promote the growth of immune organs, and promote the biosynthesis of serum protein. It can reduce the decrease of T lymphocyte and thymus atrophy, thus reducing the immunosuppressive effect. Carotene has a special effect on immune response, which can promote immune function by eliminating singlet oxygen and other free radicals [13-15]. Spirulina does not accumulate starch, but accumulates sugar in animal liver.

2. Theoretical Basis

2.1. Vitamin C

Vitamin C is a water-soluble vitamin and exists in the form of reduced ascorbic acid and dehydroascorbic acid. It is rich in vitamin C, and our body can quickly absorb vitamin C with the intestines and stomach. Under certain special conditions, the absorption of vitamin C will be gradually reduced [16]. Vitamin C in food can be quickly absorbed by the intestines and stomach, but in some special cases, it will reduce the absorption of VC. The stomach acid is insufficient, easy to be destroyed after taking. VC absorption is widely distributed in all parts of the human body. In the blood, vitamin C is in the blood cells, white blood cells and platelets are more. The level of vitamin C in the plasma will be relatively low, there will be bad blood. Therefore, we should pay attention to timely supplement vitamin C intake, only maintain the normal vitamin content, can the body maintain the normal state. If the oxidized form continues to be oxidized, it will lose its physiological activity. The latter is oxidized to L-threonine of oxalic acid [17-19].

VC plays a very important role in many aspects of life activities [20]. VC can promote the absorption of iron. VC is an indispensable nutrient for organism. It is a strong antioxidant. It has strong ability of scavenging endogenous and exercise-induced free radicals, which is closely related to the realization of human physiological function. There are enzymes or non enzymatic substances to scavenge free radicals. The main enzyme scavengers were SOD, cat and GSHPx. Non enzymatic scavengers include VC, VE, - carotene, cysteine and glutathione. They maintain the dynamic balance of free radical production and clearance in vivo through their respective pathways [21-22].

2.2. Spirulina

The development and utilization of Spirulina platensis is worth studying at present. Spirulina contains more trace elements in beauty, and it has no toxic effect and side effects on the skin. Spirulina active substances can also reduce free radicals, and the anti-aging speed is to enhance the

antioxidant capacity and improve the immune capacity. It also contains more nutrients and protein It can be used as energy for protein intake [23]. Extraction of natural substances: extraction of carotene from natural plant materials or processed leftovers with organic solvents. The higher the temperature, the higher the yield. Therefore, supercritical carbon dioxide was used to extract carotene. All the carotenes in the synthetic products are trans structure. Compared with the chemical synthesized carotene, the natural extracted carotene has better anticancer effect and has no toxic side effects. Biosynthesis: biosynthesis is a method of synthesizing carotene in vivo by microbial culture technology, and then separating carotene from microorganisms [24].

Linolenic acid, which can not only inhibit the spread of cancer cells, but also treat arthritis, obesity and heart disease and other diseases. The immune response process of human body is a more complex regulatory system. Under our physiological conditions, cytokines and immune regulatory substances clear and resist foreign substances through humoral immunity and cellular immunity. And can limit their own immune excess. Under pathological conditions, it may be that the mediators of these anti-inflammatory diseases do not provide sufficient control of the diseases caused by inflammation, or excessively inhibit the diseases caused by inflammatory activities and immune reactions, resulting in the decline of the anti infection ability of the human body, leading to repeated infection. Cytokine is a kind of highly active and multifunctional protein, polypeptide molecule or glycoprotein produced by active immune cells and related cells. As an intercellular signal transduction molecule, it mediates and regulates immune response and inflammatory response. Inflammation and anti-inflammatory factors, their interaction is an important part of the immune system, and there is an indispensable position in the immune response. Regulating inflammatory response through the interaction between these cytokines and their inhibitors is a very complex process. Because in fact, the immune system has many ways to regulate similar physiological factors. When foreign substances invade the body, the body, like a warrior, activates its own immune system to eliminate the invading enemy. However, under abnormal circumstances, because the immune system is relatively low, the body can not activate this system to help eliminate the invading enemy, and the collective can not work normally and can not return to normal state, so it will cause immune diseases The challenge of cytokines to the immune system is complex. With the development of individual immune response, it produces the interaction and balance between inflammation and anti-inflammatory. Spirulina can improve product quality, increase farmers' income and promote the development of aquaculture [25]. Application in health care: the comprehensive nutrition of Spirulina is very beneficial to human health. Using spirulina to assist disease treatment and develop health care products has become a research hotspot. Application in environmental protection: Spirulina in the growth process is affected by many environmental factors, such as N, P and some trace elements, such as light, temperature, pH value, etc[26-27]. Spirulina Polysaccharide or its complex has good anti-tumor effect and little side effect, so it has broad prospects in the development of new anticancer drugs[28]. Polyphenol is a rich and diverse plant secondary metabolite, which exists in a variety of daily food and traditional plant medicine. It is a compound that can promote human health. Fruits and vegetables, wine and tea are important sources of polyphenols in our daily intake. According to the number and structure of phenolic units, polyphenols can be divided into stilbenes, flavonoids, phenolic acids and lignans.

2.3. Exercise Endurance

Aerobic exercise can enhance our metabolism and activate hormone levels. Oxygen free radicals in the body can also be constantly eliminated metabolism, the body's free radical defense function, it can protect cells, not be damaged by free radicals oxidation, when the treatment of lack or malnutrition, vitamin supply will be lack, thus affecting the human body to absorb vitamins, make

the human body function further decline, many carbohydrates, fat, protein and other energy Matter is the necessary energy source for human body. The coupling of calcium dissolved and oxidized phosphoric acid in cytoplasm and mitochondria reduced Na ion, changed membrane potential and action potential, and reduced motor ability. With the decrease of energy consumption, muscle working ability and glutathione oxidation, the intracellular calcium binding decreases, the calcium regulation imbalance and the increase of free calcium ion, which leads to the occurrence of exercise-induced fatigue. If carbohydrates are deficient or malnourished, it often reflects a lack of food, or even a lack of food, so it becomes a state of hunger. PUFA (essential fatty acids for people). Elements in the human body other than carbon, hydrogen, oxygen and nitrogen are called minerals. According to its content and human daily needs, it can be divided into macro elements and essential trace elements. Copper deficiency leads to the deposition of iron in tissues, and iron leads to the increase of free radicals in tissues. It has many functions. It is related to the integrity and stability of membrane structure, gene expression and control, hormone synthesis and secretion, immunity and reaction, production and elimination of free radicals, transmission of nerve information and other important life activities. These functions of zinc are closely related to exercise ability.

Polysaccharide is a kind of immunomodulator and has no cytotoxicity. Polysaccharides from different sources have different immunomodulatory effects on immune function. At the same time, it can secrete or activate T cells, B cells, NK cells, macrophages and other immune cells, promote immune cells to secrete cytokines, and enhance the body's non-specific immunity, humoral immunity and cellular immunity. Food, probiotics, pathogens, and even drugs may interact with DC cells on the intestinal mucosal surface, which can be phagocytized and transferred to other immune cells, or directly bind to the immune receptor surface of the DC activated signal transmission system and cytokine synthesis system of the body. Sports nutrition can be divided into two aspects. On the one hand, it refers to some basic nutrients, such as sugar, protein, fat, vitamins, trace elements and water; on the other hand, it refers to some nutritional supplements, such as creatine, fructose and branched chain amino acids.

Carbohydrate: sugar is one of the important components of the human body, is the main energy supply material of the human body, the main sugar in the human body is glucose and glycogen. Glucose is closely related to endurance exercise. Glycogen storage and blood glucose level directly affect exercise endurance. Adequate glycogen reserve can maintain the blood glucose concentration during long-term exercise and delay the occurrence of central fatigue and peripheral fatigue. Starch, glucose, sucrose, fructose and so on all have their own functions, so they should be taken reasonably. The key point of intake should be starch polysaccharide, whose energy supply is relatively slow and lasting. Lipids: lipids are important energy substances in human metabolism. Lipid is an important component of cell membrane and nerve tissue, which plays an important role in the integrity of nerve tissue and cell membrane and the transmission of nerve impulse. In high-intensity exercise, sterols in fat play an important role in maintaining a high level of oxygen supply. It can reduce the content of creatine in urine, make creatine react with ATP to synthesize CP, and partly regulate the recovery of muscle glycogen after exercise; antiphosphoric acid can protect the body from oxidative damage by eliminating free radicals and reducing the formation of lipid peroxide (LPO). After a large amount of fat mobilization in the process of exercise, the concentration of free fatty acids in blood increases significantly, which not only provides the substrate of oxidative metabolism for muscle and other organs in exercise, but also saves the consumed sugar reserve, which is conducive to improving exercise endurance. Protein: protein is the main raw material of muscle. It is the main component of hemoglobin, myoglobin, various enzymes and hormones. It has an important influence on muscle contraction, oxygen supply and exercise regulation. At the same time, it affects the excitability of nervous system and the stability of internal environment, which has an important impact on fatigue. Athletes need more protein than

ordinary people. In the early stage of increasing exercise, growth and development period, weight loss period, energy shortage and sweating period, strengthening protein nutrition can delay the occurrence of fatigue. Branched chain amino acids and creatine: branched chain amino acids (BCAA) are mainly catabolized in muscle and are easily oxidized to energy supply. BCAA supplementation is helpful to maintain normal human brain activity and reduce or delay exercise-induced fatigue. Creatine, a derivative of amino acid, is an important raw material of CP. Creatine supplementation can promote the synthesis of CP in muscle cells, increase the content of CP, and increase the maximum contractile force of muscle. ATP utilization will also increase. It can buffer the accumulation of lactic acid in muscle and reduce the pH in the body. Vitamin B, vitamin E and vitamin A can assist glucose metabolism and energy metabolism. Make the nerve function normal. Moreover, the lack of activity and antioxidation increased, and the occurrence of sports fatigue increased. But not all the biochemical indexes of exercise fatigue are caused by the high load. When the index changes in the process of exercise, the index which is consistent with the exercise load and intensity can be used as the evaluation index. In addition, there are some active substances can also be used as its detection indicators, through these detection materials and sensitive detection methods, we can easily detect the degree of fatigue of the body, as well as other characteristics. The normal new supply maintains the body's oxidation balance and can eliminate certain free radicals. Metal lithium thioprotein, which is a complex protein under the action of the heart.

Zinc can competitively block its binding with mercaptan, and prevent the oxidation of iron, thus preventing free radicals from damaging cells. But the breath is the human body essential trace element, the human body to its demand is also relatively important. When the intensity and range of exercise step by step increase, our body's energy and oxygen consumption will increase, then oxygen consumption, reactive oxygen species will also increase, free radical metabolism will be more, and the degree of peroxidation will also increase. Vitamin C can also be used as an antioxidant, it can block the oxidation reaction of free radicals, so vitamin C and other free radical scavengers, it can further reduce the free radicals in the body, is excessive exercise or stress state of the free radicals are reduced, so as to protect the integrity of the biofilm, is our body's necessary substances, we have two The first is the enzyme defense system, the second is the non enzyme defense system. These two systems are very important to the human body, and vitamin E is an important antioxidant in the non enzyme defense system of human body.

3. Experiment

3.1. Research Object

Male rats, weighing 268-22 weeks, were provided by the experimental center. During the experiment, the room temperature was kept at 22-27 ℃, and the relative humidity was kept at 50% - 60%. Light time changes with nature. Each cage is divided into 10 cages. All the mice were fed with basic feed and boiled water, and they were free to eat.

3.2. Grouping and Processing

80 mice were used for 7 weeks. After entering the laboratory, the rats were reared adaptively for 1 week to adapt to the laboratory environment. After that, they were randomly divided into 8 groups with 10 mice in each group: quiet control group A, VC group B, spirulina group C, VC Spirulina mixture Group D. each group of mice had regular feeding method, and the control group was given normal saline gastric management. The mice in each group were weighed and their weight was recorded every week. The living conditions of the mice in each group were observed until the end

of the experiment.

3.3. Experimental Plan

The mice in the experimental group received 6-week incremental swimming training without weight-bearing. The first week of training is 30 minutes / D, then increased by 10 minutes per week, and then 80 minutes / D. in the sixth week, work six days a week and take a day off. On the seventh week of the first day, the mice in the training group were swimming with fixed load and without load (180 minutes). The next day, the mice in the experimental group were placed under a load equal to 8% of their body weight for a thorough swimming exercise. The criteria for depletion are the same as before. The water temperature is controlled at 32 ±2 ℃ and the water depth is 45cm. Use ordinary mercury thermometer and advanced dry hygrometer to measure room temperature and humidity. The weight of mice was measured by electronic balance. Swimming time is measured by an electronic timer.

Data processing: convert the time data of the whole experiment into 60 systems, the time is expressed in minutes (min), the mass is expressed in grams (g), and the capacity is expressed in ml (ML). All experimental data were analyzed by SPSS11.0 software and expressed as mean ± standard deviation (x ±SD). The significance test was t test, and the significance level was $p < 0.05$.

Weight bearing swimming experiment: on the 4th and 5th day of adaptive feeding, mice in each group were trained in swimming pool for 20 minutes without load. The size of the animal swimming pool is 100cm ×50cm ×80cm transparent glass tank with a small submersible pump at the bottom. The water depth is 45 cm and the water temperature is 32 ±2 ℃. Then on the first day of the first week and the fifth week, each group of mice swam at 4% and 8% of their body weight on the first day of the sixth week. Weight bearing method: paste medical adhesive tape on the tail 2-3cm away from the tail root of mice, open a hole, and then hang the metal object on the tape with a return needle, and then take out the tape and metal object after swimming. Then put it into the incubator, dry it with a hair dryer, and then put it back into the cage for routine feeding.

Index detection method: hemoglobin (HB) detection principle -- cyanide iron colorimetric method, Hb exists in red blood cells. After hemolysis, Hb overflowed. After emulsifying with trifonx-100, it is easy to react with Drabkin and s solution to form methemoglobin cyanide. The absorption is the largest at 540nm, and the content of Hb can be calculated by calculation. The principle of whole blood lactic acid (LAC) colorimetry is that NAD + is used as hydrogen receptor, LDH catalyzes the dehydrogenation of lactic acid to pyruvate, and pyruvate converts NAD + into NADH. The results showed that the absorbance of NBT was linear with the content of lactic acid at 530nm. The detection principle of creatine kinase (CK) - colorimetric method, creatine kinase catalyzes adenosine triphosphate and creatine to produce creatine phosphate. The latter is rapidly hydrolyzed to phosphoric acid. At this time, ATP and ADP remained stable. Molybdophosphoric acid can be prepared by adding ammonium molybdate, which can be partially reduced to molybdic acid. According to the amount of inorganic salt, the activity of enzyme can be calculated. The detection principle of blood urea nitrogen (BUN) - Urease method under the condition of heating and acid, urea and diacetyl condense to form red diazine, which is called Ferran reaction. Urea nitrogen content can be calculated according to color depth.

3.4. Experimental Results

(1) Impact on weight

Table 1. Impact on weight

Time / day	A	B	C	D
7	29.96±2.42	30.42±2.31	31.64±1.81	29.23±2.66
14	33.48±1.85	34.16±2.15	34.71±2.21	33.75±2.25
21	35.72±2.52	36.78±2.61	37.0±2.53	36.27±1.61
28	40.65±3.60	40.69±1.82	40.67±1.15	39.42±1.49
35	44.22±3.24	43.75±2.77	43.43±1.66	43.27±1.63
42	46.66±2.33	45.45±2.22	46.39±2.76	46.09±2.56
44	47.75±2.15	46.55±2.33	47.45±2.22	47.42±2.21

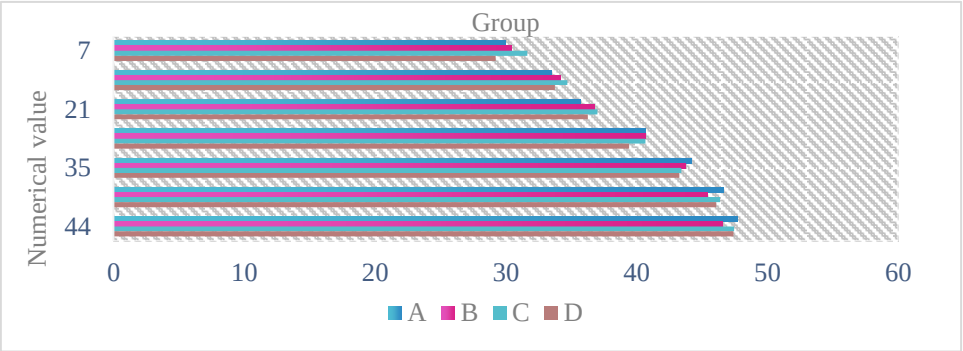

Figure 1. Impact on weight

According to the statistical analysis of data, as shown in Figure 1 and Table 1, the weight of mice in each group increased normally and grew well during the whole experiment. Compared with the experimental group, the weight gain of quiet group was faster, but there was no significant difference ($P > 0.05$).

(2) Exhaustion time

Table 2. Exhaustion time

Group	Exhaustion time	Exhaustion delay rate /%
A	58.16±10.17	10
B	69.57±13.52	19.48
C	93.56±9.72	34.47
D	82.92±11.98	20.07

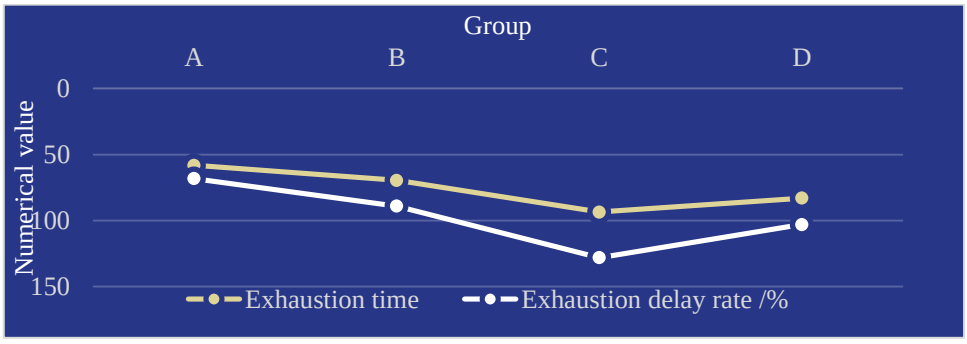

Figure 2. Exhaustion time

According to the statistical analysis of data, as shown in Figure 2 and Table 2, there was significant difference between group C of Spirulina mixture and group D of VC Spirulina mixture ($P < 0.05$), and the delay rate of depletion time was 34.47% and 20.07% respectively; there was also significant difference between group D of VC Spirulina mixture and group C of Spirulina ($P < 0.05$).

(3) Comparison of Hb and LD

Table 3. Comparison of Hb and LD

Group	Hb	LD
A	128.64±11.35	5.27±0.45
B	133.05±7.47	5.11±0.21
C	138.35±14.22	4.95±0.21
D	99.20±8.23	20.08±2.68

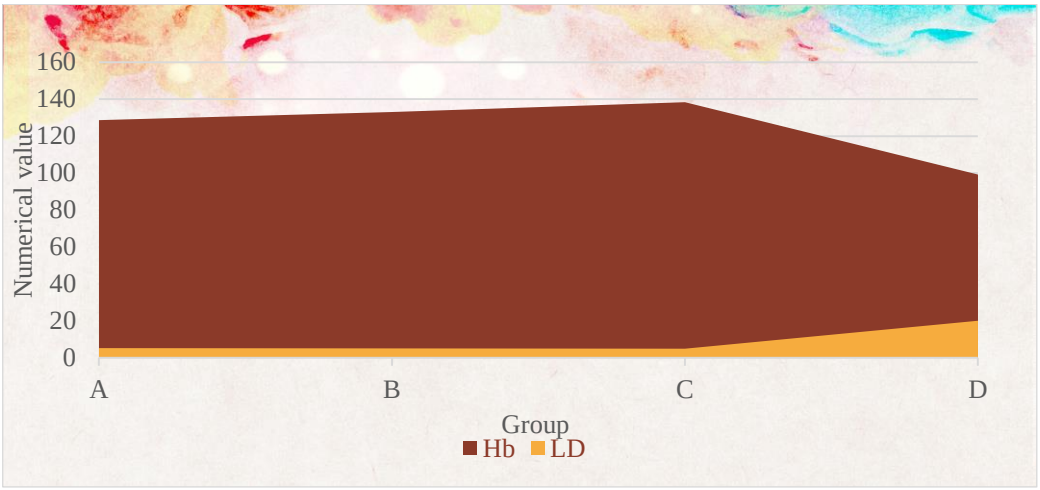

Figure 3. Comparison of Hb and LD

According to the statistical analysis of data, as shown in Figure 3 and Table 3, there was no significant difference in Hb content between group B of VC group and group A of quiet control group ($P > 0.05$), but there was a certain upward trend among the groups; group A and VC Spirulina mixture group ($P > 0.05$); while the difference between Spirulina C group and VC Spirulina mixture group D was statistically significant ($P < 0.05$); Spirulina C group and VC Spirulina mixture group ($P < 0.05$). In resting state, the whole blood LD concentration of each resting group was lower, there was no significant difference between VC group B and resting control group A ($P > 0.05$); there was significant difference between group C and group D of VC Spirulina mixture ($P < 0.05$); there was significant difference between group C of spirulina mixture and group D of VC Spirulina mixture ($P < 0.05$).

(4) Comparison of CK and BUN

Table 4. Comparison of CK and BUN

Group	CK	BUN
A	59.39±3.92	7.89±0.48
B	57.23±3.48	7.83±0.43
C	55.49±4.53	7.56±0.44
D	90.15±3.78	11.27±0.85

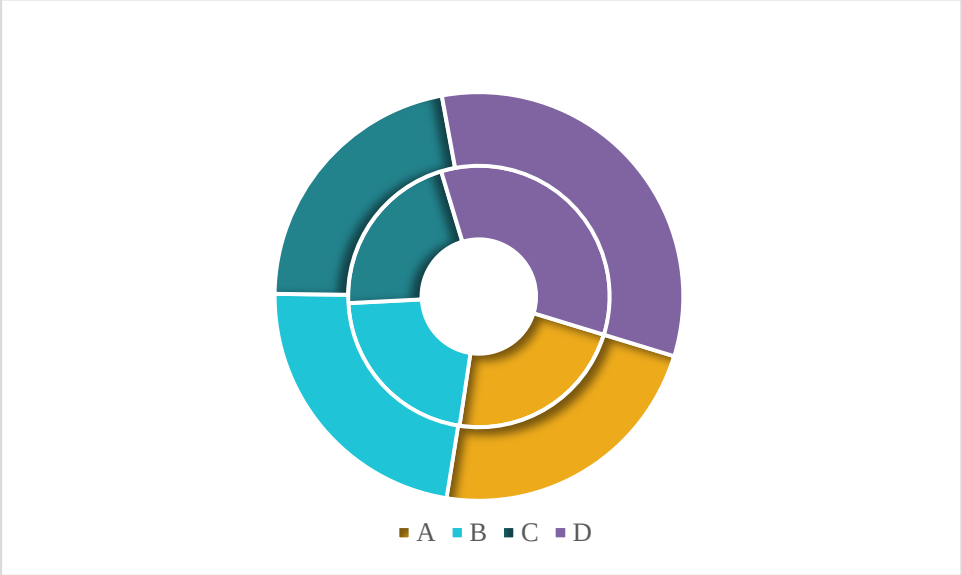

Figure 4. Comparison of CK and BUN

According to the statistical analysis of data, as shown in Figure 4 and Table 4, the serum CK activity of each group was in the normal low level range under the resting state. The serum CK activity was lower in all resting groups. There was no significant difference between VC group B and quiet control group A ($P > 0.05$). There was significant difference between group C of Spirulina mixture and group D of VC Spirulina mixture ($P < 0.05$); there was no significant difference in serum BUN content between group B of VC group and group A of quiet control group ($P > 0.05$); there was significant difference between training control group and spirulina group C and VC Spirulina mixture group D ($P < 0.05$); there was significant difference between group C of Spirulina mixture and group D of VC Spirulina mixture ($P < 0.05$).

3.5. Analysis and Discussion

VC can maintain their own body weight at the same time for sports training mice to supplement nutrition. The increase of Hb content can improve the exercise ability of the body. In the process of blood circulation, red blood cells need continuous deformation and recovery, which will lead to the destruction of red blood cells by mechanical impact, and the ability of cell membrane deformation is reduced, which makes it stagnate and be phagocytized.

The changes of fatigue behavior were delayed, insensitive, decreased coordination ability, insomnia and irritability. Physical fatigue is caused by physical activity or muscle activity, mainly manifested in the decline of exercise ability. After a period of exercise, the body can not maintain the original work intensity, that is, exercise-induced fatigue occurs in the central nervous system, central fatigue is a highly comprehensive process, it is difficult to give an accurate definition. Intense or long-term exercise leads to central nervous system homeostasis and central fatigue. The synthesis, release and resorption of acetylcholine are essential for muscle strength. Acetylcholine plays a role in the neurons of the central nervous system and the preganglionic fibers of the sympathetic nerve. In the central nervous system, acetylcholine is associated with memory, consciousness and thermoregulation. Dopamine (DA) is the first neurotransmitter to be shown to play a role in central fatigue. In the central nervous system, lactic acid, as the substrate of energy pool, has been paid more and more attention. Lactic acid is an intermediate in glucose metabolism.

Blood lactic acid is not the main source of brain lactic acid. In vitro perfusion of sodium lactate can significantly increase the blood lactic acid concentration, but the blood lactic acid concentration in jugular vein does not change much. It provides energy for neurons and maintains the normal function of neurons. In addition, lactic acidosis caused by lactic acid accumulation is the pathological basis of hypoxic-ischemic encephalopathy and brain injury, which can lead to brain cell damage. It is suggested that the change of lactate t may be related to the mechanism of exercise-induced central fatigue.

4. Conclusion

Vitamin C Spirulina mixture can inhibit the decrease of Hb content, improve the ability of aerobic metabolism, delay the occurrence of exercise-induced fatigue, inhibit the production of LD in mice, accelerate the gap of LD, significantly reduce the damage of skeletal muscle and other tissues and cells, and reduce the oxidative decomposition of protein and amino acids.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Munjal, C. , & Bhattacharyya, S. . (2016).“ Supplementation of Spirulina and Vitamin c Attenuated the Nephrotoxicity Induced by Cisplatin Administration”, International Journal of Research - GRANTHAALAYAH,4(1), pp.93-107. https://doi.org/10.29121/granthaalayah.v4.i1.2016.2847

[2] Walid Hamdy El-Tantawy. (2016).“ Antioxidant Effects of Spirulina Supplement Against Lead Acetate-Induced Hepatic Injury in Rats”, Journal of Traditional & Complementary Medicine, 6(4), pp.327-331. https://doi.org/10.1016/j.jtcme.2015.02.001

[3] Arabi, Hojat, Gholipour Kanani, Hosna, Shahsavani, Davar, & Harsij, Mohammad. (2016). “Improving Effect of Spirulina Platensis on Hematological Parameters in Cyprinus Carpio Exposed to Sublethal Doses of Cyanide”, Comparative Clinical Pathology, 25(2),pp. 335-342. https://doi.org/10.1007/s00580-015-2187-8

[4] Djibrine, S. I. , Minet-Quinard Régine, Djidda, M. A. , Ngoua Hadjé Fatimé, Arada, I. A. , & Abdelsalam, T. , et al. (2018). “Vitamin a Status in Healthy Women Eating Traditionally Prepared Spirulina (Dihé) in the Chad Lake Area”, Plos One, 13(1), pp.e0191887. https://doi.org/10.1371/journal.pone.0191887

[5] Wu, Q. , Liu, L. , Miron, A. , Klímová, Blanka, Wan, D. , & Ku?A, K. . (2016).“ the Antioxidant, Immunomodulatory, and Anti-Inflammatory Activities of Spirulina: an Overview”, Archives of Toxicology, 90(8), pp.1817-1840. https://doi.org/10.1007/s00204-016-1744-5

[6] Hilda Ma González, Almirall, I. , Jesús Alpízar, Oca, R. M. D. , & Víctor Cerdà. (2020)." Determination of Vitamin e in Spirulina Platensis Extracts and Photoprotective Creams by Multi-Syringe Chromatography (Msc) and High-Performance Liquid Chromatography (Hplc)", Analytical Letters(1), pp.1-11. https://doi.org/10.1080/00032719.2020.1762629

[7] Shinde, S. , Lavale, S. A. , & Nagare, K. . (2018)." 'Spirulina' As An Additive for Better Nutrition", International Journal of Current Microbiology and Applied ences, 7(5),pp. 143-147. https://doi.org/10.20546/ijcmas.2018.705.018

[8] Ye, J. , Li, J. , Li, Z. , & Han, S. . (2017)." Rearing of Mallada Basalis (Neuroptera: Chrysopidae) on Modified Artificial Diets", Plos One, 12(9),pp. e0185223. https://doi.org/10.1371/journal.pone.0185223

[9] Abdel-Daim, & Mohamed, M. . (2016). "Synergistic Protective Role of Ceftriaxone and Ascorbic Acid Against Subacute Diazinon-Induced Nephrotoxicity in Rats", Cytotechnology, 68(2), pp.279-289. https://doi.org/10.1007/s10616-014-9779-z

[10] Karadal, O. , Güroy, Derya, & Türkmen, Gürel. (2017). "Effects of Feeding Frequency and Spirulina on Growth Performance, Skin Coloration and Seed Production on Kenyi Cichlids (Maylandia Lombardoi)", Aquaculture International, 25(1), pp.121-134. https://doi.org/10.1007/s10499-016-0017-x

[11] Alejandro Ríos-Hoyo, Romo-Araiza, A. , Meneses-Mayo, M. , & Gabriela Gutiérrez-Salmeán. (2017)." Prehispanic Functional Foods and Nutraceuticals in the Treatment of Dyslipidemia Associated to Cardiovascular Disease: a Mini-Review", International Journal for Vitamin and Nutrition Research, 87(1-2), pp.1-14. https://doi.org/10.1024/0300-9831/a000290

[12] Cai, J. , Shi, Y. , Li, X. , & Zhang, D. . (2017). "The Elongation Performance of Spirulina -Templated Silver Micro Springs Embedded in the Polydimethylsiloxane", Journal of Bionic Engineering, 14(004), pp.631-639. https://doi.org/10.1016/S1672-6529(16)60429-8

[13] Umoren, S. A. , Eduok, U. M. , Solomon, M. M. , & Udoh, A. P. . (2016). "Corrosion Inhibition by Leaves and Stem Extracts of Sida Acuta for Mild Steel in 1 m h2so4 Solutions Investigated by Chemical and Spectroscopic Techniques", Arabian Journal of Chemistry, 48(S1), pp.S209-S224. https://doi.org/10.1016/j.arabjc.2011.03.008

[14] Nadège Tekaya, Saiapina, O. , Ouada, H. B. , Lagarde, F. , Namour, P. , & Ouada, H. B. , et al. (2017)." Bi-Enzymatic Conductometric Biosensor for Detection of Heavy Metal Ions and Pesticides in Water Samples Based on Enzymatic Inhibition in Arthrospira Platensis", Journal of Environmental Protection, 5(5), pp.441-453. https://doi.org/10.4236/jep.2014.55047

[15] Zhang, C. , Tang, X. , Sheng, L. , & Yang, X. . (2016)." Enhancing the Performance of Co-Hydrothermal Liquefaction for Mixed Algae Strains by the Maillard Reaction", Green Chemistry, 18(8), pp.2542-2553. https://doi.org/10.1039/C5GC02953H

[16] Sandra López-León, Tuvblad, C. , & Forero, D. . (2016)." Sports Genetics: the Ppara Gene and Athletes' High Ability in Endurance Sports. a Systematic Review and Meta-Analysis", Biology of Sport, 33(1),pp. 3-6.

[17] M.D. Hoffman. (2016). "State of the Science-Ultraendurance Sports", Int J Sports Physiol Perform, 11(6), pp.831-832. https://doi.org/10.1123/IJSPP.2016-0472

[18] Groth, S. , & Krahn, Y. . (2017)." Sensing Athletes: Sensory Dimensions of Recreational Endurance Sports", Journal of Ethnology & Folklors, 11(2),pp. 3-23. https://doi.org/10.1515/jef-2017-0011

[19] Almekinders, L. C. , & Engle, C. R. . (2019). "Common and Uncommon Injuries in Ultra-Endurance Sports", Sports Medicine and Arthroscopy Review, 27(1), pp.25-30. https://doi.org/10.1097/JSA.0000000000000217

[20] *Finocchiaro, G. , & Sharma, S. . (2016).“ Do Endurance Sports Affect Female Hearts Differently to Male Hearts?”, Future Cardiology, 12(2), pp.105-108. https://doi.org/10.2217/fca.15.85*

[21] *López-Rivera, Eva, & González-Badillo, Juan José. (2019).“ Comparison of the Effects of Three Hangboard Strength and Endurance Training Programs on Grip Endurance in Sport Climbers”, Journal of Human Kinetics, 66(1),pp. 183-195. https://doi.org/10.2478/hukin-2018-0057*

[22] *Calvo, J. L. , Alorda-Capo, F. , Pareja-Galeano, H. , & Sergio L Jiménez. (2020).“ Influence of Nitrate Supplementation on Endurance Cyclic Sports Performance: a Systematic Review”, Nutrients, 12(6), pp.1796. https://doi.org/10.3390/nu12061796*

[23] *Rundell, M. B. , & Rundell, K. W. . (2020).“ Teen with Psychiatric Diagnoses Improves after Eliminating Medications and Initiating Endurance Sports Training”, Current Sports Medicine Reports, 19(1), pp.6-7. https://doi.org/10.1249/JSR.0000000000000678*

[24] *José Miguel Martínez-Sanz, Ana Fernández Nuez, Sospedra, I. , Alejandro Martínez-Rodríguez, & Antonio Jesús Sanchez-Oliver. (2020). “Nutrition-Related Adverse Outcomes in Endurance Sports Competitions: a Review of Incidence and Practical Recommendations”, International Journal of Environmental Research and Public Health, 17(11),pp. 4082. https://doi.org/10.3390/ijerph17114082*

[25] *Szymon Kuliś, Sienkiewicz-Dianzenza, E. , & Stupnicki, R. . (2020).“ Anaerobic Endurance of Dance Sport Athletes”, Biomedical Human Kinetics, 12(1), pp.141-148. https://doi.org/10.2478/bhk-2020-0018*

[26] *Lou, R. , Lv, Z. , Dang, S. , Su, T. , & Li, X. . (2021). Application of machine learning in ocean data. Multimedia Systems, 1-10. https://doi.org/10.1007/s00530-020-00733-x*

[27] *Y. Zhang, L. Sun, H. Song and X. Cao, "Ubiquitous WSN for Healthcare: Recent Advances and Future Prospects," in IEEE Internet of Things Journal, vol. 1, no. 4, pp. 311-318, Aug. 2014, doi: 10.1109/JIOT.2014.2329462.*

[28] *Mohammed I. Alghamdi, Neutrosophic set with Adaptive Neuro-Fuzzy Inference System for Liver Tumor Segmentation and Classification Model, International Journal of Neutrosophic Science, 2022, Vol. 18, No. 2, pp: 174-185.https://doi.org/10.54216/IJNS.180202*