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Supplementing Branched Chain Amino Acids on Some Hormone Responses of Athletes

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Abstract: In order to improve their body performance, athletes often carry out long-term endurance training. The important factors that determine the endurance of athletes include their own metabolic level, physical and psychological responsiveness during exercise. The branched chain amino acids have a great influence on these factors. The purpose of this article is to study the effect of supplementing branched-chain amino acids on some hormone responses of athletes. Through the use of comparative experiments and radioimmunoassay, 20 volunteer athletes were recruited for a two-month experimental investigation. Modern measuring instruments and methods were used to record and observe the changes in the body-related hormones of supplemented branched chain amino acids and unsupplemented experimenters. In addition, in order to explore the specific effects of branched chain amino acids, the injection dose was controlled and grouped in detail. Research results show that branched-chain amino acids can adjust and improve some hormones in athletes' plasma. Low content of branched chain amino acids can reduce the rate of decrease of T/C ratio in athletes by about 20% during exercise, and can increase their protein synthesis and metabolism rate by 10%. It can increase the growth hormone in the body by 2.3 index points, which can greatly relieve the athlete's sports fatigue.

1. Introduction

After analyzing its chemical structure, it was named Leu. Ile is first separated from beet syrup, and then prepared from the trypsin hydrolysate of various proteins. It was found that its chemical composition is the same as Leu, but its physical and chemical properties are different, so it was identified as another amino acid and named Ile. Isolated from pancreatic extract, its structure is composed of amino-isovaleric acid. In recent years, the research on its biological function and mechanism has gradually increased and deepened.

BCAA metabolism rate-limiting enzyme-branched-chain activity-keto acid dehydrogenase complex (BC complex) is very strong in muscles, thereby enhancing the muscle's ability to use BCAA [1]. At the same time, BCAA is also used as an energy substrate, a gluconeogenesis substrate

and a regulator of muscle protein metabolism. As a sports nutrition supplement, BCAA has been extensively studied in sports training. This article aims to summarize the relationship between BCAA and body movement [2]. BCAA includes leucine, isoleucine and apparent acid. Since it cannot be synthesized by itself in humans, livestock and poultry (mainly bacteria, fungi and plants), it must be obtained from food, so it is also an essential amino acid [3]. Similarly, at present, BCAA has a wealth of research and practical applications in the field of sports (such as nutrition, etc.), mainly focusing on anti-fatigue and improving athletic ability. In recent years, the research on its biological function and mechanism has gradually increased and deepened.

In order to explore the effect of supplementing branched chain amino acids on some hormone responses of athletes, a detailed experimental analysis was carried out in this article. In this article, Kita conducted a detailed study on how to improve athletes' endurance, analyzed various amino acids and derivatives, and finally determined the feasibility of branched chain amino acids to improve athletes' endurance in various experimental comparisons, it can effectively improve the endurance of athletes [4]. Yan conducted a follow-up study on 15 athlete experimenters for several months, and compared the effects of different doses of branched chain amino acids on the improvement of athletes' tolerance, the experiment found that branched chain amino acids can cause various hormone responses in athletes [5]. Kawaguchi found through related studies that supplementing a certain dose of branched-chain amino acids can cause a decrease in athletes' T/C value, thereby reducing athletes' exercise fatigue and improving athletes' tolerance [6]. Morales found through research that branched chain amino acids can increase the rate of protein synthesis and metabolism in athletes, thereby increasing the athlete's physiological response and keeping the mental state in a good state [7]. In order to study the effect of supplementing branched chain amino acids on certain hormone responses of athletes, Osorio used modern instruments and immune tracking methods to conduct research from the molecular level, and found that branched chain amino acids can increase growth hormone in athletes, which can be greatly improved, alleviate sports fatigue of athletes [8].

This article mainly conducts a detailed research and investigation on the mechanism and effect of supplementing branched chain amino acids on certain hormone responses of athletes. In addition, this article is innovative on the basis of previous scholars' research. The innovations are roughly as follows: First, in this article, for the first time, an in vitro injection method was used to inject multiple types of doses of branched-chain amino acids. This method is more efficient and safer than before. Secondly, this article uses radioimmunoassay for the first time to record and observe in detail the reactions and changes of hormones in exercise. Third, this article uses modern measuring instruments to investigate and track related reaction mechanisms and effects in detail from the molecular level. The accuracy and reliability of the experiment are greatly increased compared with the past.

2. Biological Functions and Mechanism of Branched Amino Acids

2.1. The Effect Mechanism of Branched Chain Amino Acids on Human Energy Metabolism

At present, BCAA has conducted extensive research in the field of sports, involving anti-fatigue, improving exercise capacity and maintaining lean body mass. BCAA is a special and important type of amino acid that will be broken down to provide energy. In the 1970s, BCAA was considered the third "fuel" after carbohydrates and fats. Next, experiments in the oxidation process of BCAA with the stable isotope 13 c-Leu label showed that the oxidation of carbohydrates and fats increased by 10 to 20 times after exercising only 2 to 3 times. The ratio of amino acids to carbohydrates to fat is not the main energy. It is a source of energy during exercise, but more and more data show that exercise, especially long-term endurance exercise, will increase the oxidation of amino acids

(mainly BCAA) in muscles with participation. The results of a comprehensive study show that the changes in plasma BCAA vary greatly with exercise time [9]. In a short period of time (15-18 minutes), under the ultimate strength, BCAA hardly changed or increased slightly. Under different intensities of BCAA, long-term load (40~150min) showed a significant increase; BCAA only showed a downward trend under long-term load (> 3h). This indicates that BCAA catabolism will increase after long-term exercise, which is presumably related to the increase in the ratio of catabolism and energy supply. The catabolism of BCAA in muscle is very active. Compared with most other amino acids, BCAA can completely transaminase and oxidize at a fairly fast speed, and provide amino groups for alanine and glutamine. BCAA decomposition products acetyl-coA and succinic acid monoaryl COA enter the tricarboxylic acid cycle and release a lot of energy, and BCAA oxidation produces ATP more efficiently than other amino acids.

According to calculations, the complete oxidation of 1ml of Val, Leu and Ile produces 32, 42 and 43mol ATP, respectively. In quiet and ordinary exercise, amino acids do not participate in oxidative energy, but BCAA is an important energy source in certain physiological states (such as hunger, lactation, diabetes, and long-term exercise). Studies have shown that fasting can increase the oxidation rate of BCAA several times, leading to a decrease in protein synthesis. During fasting, the ability of muscles to oxidize BCAA transamination products-keto acids can be increased by 3-5 times. Animal experiments also showed that the BCAA transaminase activity and Leu oxidation rate in the breast of lactating athletes increased. The relationship between exercise and BCAA participation in power has been studied in detail. "Drip can" sports nutrition preparations (BCAA as the main ingredient) can significantly enhance lactic acid metabolism, promote protein synthesis, enhance muscle strength, and provide energy reserves for endurance. Athletes, it shows that BCAA has a good effect on long-term intensive exercise [10]. The possible mechanism for the enhancement of the ability of skeletal muscle to oxidize BCAA during exercise may be due to the fact that exercise training increases the secretion of catabolism hormones in the body and improves the enzyme activity and energy utilization efficiency of BCAA oxidation and decomposition. Exercise increases the activity of the BC complex required for the metabolism of BCAA in muscle, thereby increasing the oxidative utilization of BCAA in skeletal muscle.

2.2. Effects of Branched Chain Amino Acids on Catabolism and Mitochondrial Function in Athletes

Tyrosine, phenylalanine and 3-methylhistidine can be used to reflect the degradation of protein in muscle, because the first two aromatic amino acids can only be produced by dissociating muscle protein, and cannot be absorbed by skeletal muscle, and their quantitative changes in serum and plasma muscles can reflect the degree of protein breakdown. 3-methylhistidine is a catabolite of actin and myosin and cannot be reused or further metabolized. At present, the results of research on the effect of BCAA on muscle protein are still controversial. 30-kilometer trail running, full marathon running and electric bicycle experiments have shown that the increase of tyrosine and phenylalanine in muscle and plasma is inhibited after BCAA supplementation. After feeding the bedridden patient with BCAA nasogastric feeding for two weeks, the patient's protein degradation was significantly reduced, which was manifested by a significant decrease in urea nitrogen and 3-methylhistidine content in urine. Animal studies also show that BCAA can inhibit the breakdown of muscle protein. The study found no effect on the degradation of skeletal muscle protein. More studies have shown that BCAA can only inhibit protein degradation in human tissues other than skeletal muscle [11]. In summary, we believe that the differences in research results may be related to various factors, such as exercise plan, intensity, duration, and subject's skill level. Therefore, the influence of BCAA on athletes' muscle protein catabolism needs further research and exploration.

Mitochondria are the main source of endogenous free radicals in the body, and the synergistic effect of the use of oxygen in energy synthesis can lead to the production of free radicals.

The function of mitochondria is not only to provide cells with ATP energy, but also related to signal transduction, the transmembrane transport of various ions in the cell, and the regulation of electrolyte homeostasis. Strenuous exercise will damage the body's mitochondrial membrane, and the decline in membrane fluidity will cause changes in membrane function, thereby affecting exercise capacity. Supplementing BACC can make the fluidity of the mitochondrial membrane close to the normal level. The overload of calcium ions in the mitochondria can directly inhibit the oxidative phosphorylation of mitochondria, reduce the production of ATP, and indirectly inhibit mitochondrial respiration. Therefore, supplementation of BCAA can meet energy requirements and reduce calcium iron overload. Calcium ion is one of the important reasons for the disorder of homeostasis, which leads to the appearance of new calcium ion channels on the mitochondrial damage membrane, which increases the permeability of the mitochondrial membrane and deletes 1, inhibits mitochondrial respiration, barriers to information transmission between cells, and BCAA supplements. It may significantly antagonize the calcium accumulation in myocardial tissue, normalize mitochondrial function, and the stability of mitochondria plays a role [12]. As an essential amino acid for the human body, BCAA has long been involved in sports functions and plays an important role in fighting fatigue. At the same time, it promotes the synthesis and decomposition of muscle protein, normalizes mitochondrial function and prevents calcium overload. The current research is not completely thorough, and will affect the results of the experiment more or less. The amount of exercise and the amount of exercise are related factors such as time. How to more effectively supplement the rights of BCAA needs to be further analyzed and studied in detail, and individual exercise may also be investigated. And test the physical fitness of athletes, supplement BCAA while being more scientific, and consider how to improve the level of athletes through reasonable ways into practice.

2.3. The Definition of Branched Chain Amino Acids and the Mechanism of Eliminating Sports Fatigue

BCAA is composed of three essential amino acids: leucine (Leu), isoleucine (Ile) and valine (Val), and is named after its branched chain carbon skeleton. They are three essential amino acids that the human body cannot synthesize and must be provided by food protein. Leucine is an essential amino acid and ketogenic amino acid for mammals and plays an important role in regulating amino acid and protein metabolism. Leucine is the only amino acid that can regulate the renewal of skeletal muscle and cardiac muscle protein. Other studies have shown that leucine can promote the synthesis of skeletal muscle protein. The chemical composition of isoleucine is exactly the same as that of leucine, but the arrangement is slightly different, resulting in different properties. Isoleucine is a hydrophobic amino acid. It is one of the essential amino acids. Although it is a sugar amino acid, it has almost no ketogenic effect [13]. Von group-beaned extracted valine from pancreatic extract. It mainly acts on ACTS on the corpus luteum, breast and ovary. It can promote wound healing, treat liver failure and increase blood sugar levels. When valine is insufficient, athletes will experience central nervous system dysfunction, ataxia and limb tremor. BCAA is the only amino acid that is broken down in the liver and used in muscles.

Because the activity of the rate-limiting enzyme of BCAA metabolism in muscle is relatively strong, thereby increasing the ability of muscle to utilize BCAA, the main metabolic site of BCAA is in muscle. It is known that BCAA oxidation can provide 14% of the total energy expenditure of human skeletal muscle at rest. Under certain special conditions, such as hunger and exercise, BCAA oxidation can be enhanced [14]. More and more evidence show that prolonging endurance exercise

mainly involves branched chain amino acids in energy supply. BCAA can promote protein synthesis in skeletal muscle and cardiomyocytes and resist protein breakdown. A reasonable supplement of BCAA to athletes can give full play to their athletic ability. In particular, leucine can stimulate muscle protein synthesis, increase muscle strength, and promote the improvement of strength-based exercise capacity. As a gluconeogenic amino acid, BCAA can promote the body's utilization of amino acids in the process of gluconeogenesis, and can generate glucose (or glycogen) through the gluconeogenesis of amino acids.

Using muscle glycogen in skeletal muscle can accelerate the energy conversion of the liver. Supplementing BCAA can promote the recovery of blood sugar after exercise and inhibit the production of large amounts of lactic acid in the blood, thereby reducing the accumulation of lactic acid in skeletal muscle and delaying fatigue. It has also been proved that supplementation of BCAA can inhibit the metabolism of BCAA in athletes, thereby inhibiting muscle lactic acid production and blood lactic acid concentration. BCAA increases the concentration of BCAA through the blood-brain barrier, reduces the competitive binding of FFA to albumin and trap, and reduces the concentration of f-trap in plasma and 5-HT [15]. CAA can also improve the intracellular environment: strenuous exercise can increase the release of intracellular calcium, increase the concentration of calcium ions in the heart muscle, and form calcium overload, which will cause damage to the mitochondrial membrane, inhibit mitochondrial oxidative phosphorylation, and reduce ATP production. Thereby affecting athletic ability, supplementing BCAA can reduce the calcium content in the myocardium, maintain calcium homeostasis, reduce calcium overload, and meet energy needs.

3. To Verify the Effects of Branched Amino Acids on Certain Hormones in Athletes

3.1. Selection of Experimental Objects and Experimental Exercise Methods

In the two-month experiment, all subjects had the same daily protein intake. According to the design of the random area, the participants were divided into two groups. The personal information of the experimenters is shown in Table 1.

Table 1. Details of the experimenter

Group	Number of People	Weight	Age
Experimental Group	10	62.3-65.36 kg	22.15-24.35
Matched Group	10	65.23-67.36 kg	21.56-23.15

One-time exercise: the subjects train on a 10 km rowing power meter, exercise time is 38-42min, heart rate is 160-170 beats/min, blood lactate value is 4.35±1.3mmol/L immediately. Long-term sports: athletes 6 days a week, 4 hours a day, normal sports training for two weeks. The exercise method and intensity on the last day are the same as that of one exercise. The blood lactate value immediately after exercise is 4.18±1.3mmol/L.

3.2. Test Result Measuring Instrument and Method

In the experiment, the blood ammonia content of exercisers was measured by the protein-free filtrate method. Apparatus: 722 spectrophotometer reagents: blood ammonia determination kit (including: protein precipitant 1, protein precipitant, chromogen, chromogen 1 2 2, 7 trend / L standard stock solution and standard diluent) blood ammonia. Detection principle: The use of protein precipitant can precipitate the protein and enzyme activity in the blood, prevent free ammonia in vitro, and remove most of the interference color substances. The bertha lot reaction was

used to color the ammonia in the protein-free filtrate, and the ammonia content in the blood was determined compared with the standard solution. Blood ammonia content (mol/L)=(OD-blank determination)/(OD-blank standard)×standard concentration (350 mol/L)×the dilution ratio of the sample before the test. The content of Leu, Ile, Val, trap and 5-HT in blood micro dialysis fluid was determined by capillary electrophoresis and laser-induced fluorescence.

Apparatus: P / ACE MDQ capillary electrophoresis instrument (Beckman, USA). Reagents: Leu, Ile, Val, Tarp, 5-HT standard solution, FITC, boric acid, borax and methanol capillary column, total length 57 cm, effective length 50 cm. Diameter 75 microns, diameter 375 microns. Detector: laser induced fluorescence detector, Ex488nm, Em520nm electrophoresis buffer: 75/L boric acid + 100 L SDS trend, PH = 9.42 BCAA and Tarp derivation buffer: 50mmol/L boric acid. PH = 9.85-ht derivatization buffer: 10mmol/L borax, PH=11 derivatization method: in a 0.2ml centrifuge tube with a lid, 13 L derivatization buffer, 5 L of standard or micro dialysis sample, 0.26mmol/L add FITC 2 L, derivatization in the dark, Leu, Ile, Val and Tarp at 20℃ for 16 hours, and 5-ht for 10 hours. After derivatization, it was stored in a refrigerator at -20℃ for further testing. Separation conditions: 0.5psi sample injection for 5 seconds, 25KV constant pressure separation for 20 minutes, before each injection, each capillary column is washed with 0.1n NaOH, ddH_2O, electrophoresis buffer for 1 minute, 2 minutes, 5 minutes, column temperature 25℃. Capillary electrophoresis-laser-induced fluorescence principle. Capillary electrophoresis uses high-voltage electric field as the driving force and separates through capillary channels. It is a separation technology that realizes separation according to the mobility and distribution of each component in the sample due to different behaviors. It has the advantages of fast speed, high separation efficiency, small sample amount and absolute low detection limit.

3.3. Experimental Branch Chain Amino Acid Supplement Method and Sample Collection

One-time administration: The placebo group took ordinary distilled water before exercise, and the BCAA group took 15g 5 minutes before exercise. The placebo group takes regular distilled water before and after exercise, and the BCAA group takes 15g a day, 3 times a day. The ratio of various amino acids in BCAA: Leucine 40%, Isoleucine 15%, Valine 45%. Uniport product, perform 10 km rowing dynamometer training 5 minutes after taking the supplement (one exercise) or on the 14th day (long-term exercise) after taking the supplement for 2 weeks. Blood is drawn between 7:30 in the morning before fasting exercise and 9:30 to 10:00 after exercise. Separate the plasma and take anticoagulated whole blood for testing.

3.4. Preparation of Experimental Equipment and Sample RNA

There are a lot of equipment required for the experiment, including the following: sn-682 radioimmunoassay gamma counter (Shanghai Nuovo Photoelectric Instrument Co., Ltd.). High-speed desktop centrifuge TGL-c (Shanghai Anting Scientific Instrument Factory). Leptin radioimmunoassay kit (Science and Technology Development Center of PLA General Hospital). Agarose (Shanghai Bauhaus Biotechnology Co., Ltd.). DNTP and PCR deionized water (excluding Raise) are produced by Shanghai Shenlong Bioengineering Co., Ltd., and Taq DNA polymerase is produced by Promega Shanghai. RNA extraction kit (Biamp virus RNA mini kit, Khagan, Germany), reverse transcriptase (M-Mulvey, New England Biolabs, UK). Rase inhibitor (Nippon Treasure Wine). The PCR product purification kit is the QIA quick gel extraction kit from Qiagen, Germany. All primers are synthesized by Shanghai Jing gong Biological Engineering Co., Ltd., and other biochemical reagents are domestic analytical reagents. Additional requirements: gene amp 9700 DNA amplifier (ABI), 4-15k desktop high-speed centrifuge (sigma). Circulating water bath (Beijing Electronic Equipment Co., Ltd.), dyy-5 hot-pressure stable current electrophoresis

instrument (Beijing 61 Instrument Factory), dyy-31a horizontal electrophoresis tank (Beijing 61 Instrument Factory). Wd-9403 UV detector (Beijing 61 Instrument Factory). DU530 UV spectrophotometer (Backman, USA), Bio step GmbH (Bio step, Germany) gel imager.

Incubate the required RNA at 15-30 ℃ for 5 minutes to completely decompose the nucleoprotein complex. Add 0.2 ml of chloroform to each ml of trio solution, close the lid, shake by hand for 15 seconds, then incubate at 15-30 ℃ for 2-3 minutes, and centrifuge at 2-8 ℃ at 12,000 rpm for 15 minutes. After centrifugation, the lower layer of the mixture is the red phenol-chloroform phase, the middle layer is the middle phase, and the upper layer is the colorless water phase. RNA exists in the water phase and accounts for approximately 60% of the volume of the trio liquid product. Transfer the aqueous phase to a new tube, add isopropanol, and precipitate RNA. Add 0.5 ml of isopropanol to each ml of Trizell (homogenate). Incubate at 15-30 ℃ for 10 minutes. Centrifuge the RNA at 12000 RPM for 10 minutes at 2 to 8 degrees to form gel particles at the bottom of the tube. Remove the supernatant, wash the RNA particles with 75% ethanol, and add at least 1 ml of 75% ethanol to every 20 ml of Trizell (homogeneous). Precipitate RNA by vertexing at 2-8 ℃, and centrifuge at 7500 rpm for 5 minutes. Finally, the RNA is dried in natural air (do not centrifuge and dry it in a vacuum, as this will reduce its solubility). The RNA was dissolved in 0.5% SDS, dried repeatedly with a pipette, and incubated at 55-60 ℃ for 10 minutes.

3.5. Experimental Data Processing and Algorithms

All data are expressed as mean standard deviation (X±SD), and repeated measurement data were analyzed by ANOVA using SPSS13.0, and the significance level was set to $P<0.05$. When analyzing repeated measurement data by analysis of variance, the muhly sphere test was first performed. If $P>0.05$, the spherical hypothesis is satisfied and no correction is required. If $P\leq0.05$, use the greenhouse-aisle calibration result as the test index. The algorithm required for statistical experiment data is shown in Formulas 1 and 2.

$$SS = SS_G + SS_I + S_I * 0.5S_G \tag{1}$$

$$M_S = SS/(G-1) \tag{2}$$

Among them: SS is the sum of squared deviations; MS is the sum of squared deviations.

In addition, SPSS 11.5 statistical analysis software is used for routine analysis and experimental data processing. Significant difference is expressed as = 0.05. Paired T test is used to analyze the comparison between self-control data. Data comparison of one-way analysis of variance between groups (one-way analysis of variance) is used for f-test (homogeneity test of variance). When the variances of each group are equal, the least significant difference (LSD) test item will be used to compare the average of each group, and the multiple comparison error rate will not be adjusted. When the difference is uneven, the inspection items are compared for multiple times, and the 2×2 factor analysis (Univariate) is used to analyze the influence of swimming exercise and supplementary amino acid and their interaction on related experimental indicators. When $P<0.05$, the effect is statistically significant[16-17]. All curves and histograms are generated on MATLAB.

4. Effects of Supplementary Branched Chain Amino Acids on Hormones in Athletes

4.1. Analysis on the Mechanism of Supplementing Branched Chain Amino Acids on Athletes' Resistance Exercise

The metabolism of human protein was studied by isotope tracing method. It was found that the rate of protein synthesis and protein breakdown increased 24 hours or even 48 hours after resistance

training. In order to obtain a net increase in muscle protein, proper nutrition is needed. After resistance exercise, the intake of amino acids will increase the rate of protein synthesis in human muscles, resulting in a positive nitrogen balance (that is, protein synthesis is greater than protein breakdown). The protein synthesis rate is about 5.23*109 per second, which is much higher than protein breakdown. The rate is about 65%, and the monitoring data is shown in Table 2.

Table 2. Effects of amino acids on protein synthesis rate in human muscle

Amino acid dose	Protein synthesis rate	Protein breakdown rate
0.05ml	$2.565*10^9$/s	$(45.3\pm3.34)*10^8$/s
0.078ml	$3.26*10^9$/s	$(5.4\pm7.45)*10^8$/s
0.0825ml	$5.21*10^9$/s	$(7.6\pm3.21)*10^8$/s

Studies have shown that in a short-term resistance exercise, the phosphorylation of p70 S6 kinase in threonine 389 (Thr389) muscle is necessary for the complete activation of p70 S6 kinase, so the uptake of BCAAs increases the phosphorylation of Thr389 to complete activate p70 S6 kinase. In addition, the changes of plasma BCAA vary greatly with exercise time. In a short period of time (15-18min), BCAA hardly changed or increased slightly under ultimate strength. Under long-term (40~150min) loads under various intensities, BCAA showed a significant increase. Only under long-term load (>3h), BCAA shows a downward trend. Ingestion of BCAA after exercise can also increase mTOR phosphorylation. Animal experiments have shown that the intake of BCAA will cause the phosphorylation of P70 S6 kinase and 4E-BP1 to be blocked in athletes who lack food after rapamycin intake. Rapamycin inhibits the activity of mTOR, indicating that the intake of BCAA will affect mTOR activate, and the result is shown in Figure 1.

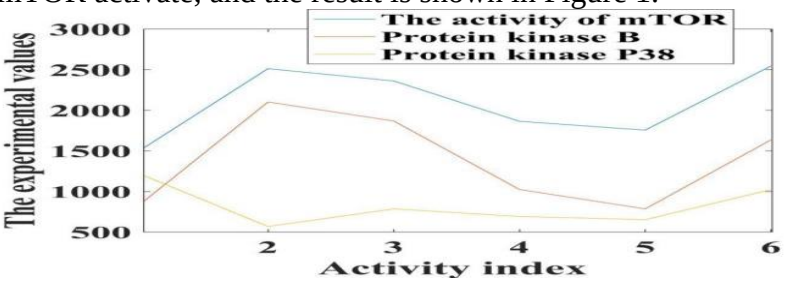

Figure 1. Activation of mTOR factor, protein kinase B and mitogen-activated protein kinase P38 by branched amino acids

From the data in Figure 1, it can be seen that the activation efficiency of branched-chain amino acids on mTOR factor is as high as 75.8%, and the activation effects on protein kinase B and mitogen-activated protein kinase P38 can reach 93.5% and 75%-80.2%, respectively.

The results showed that the serum TC levels of athletes supplemented with amino acids were significantly lower (1.45 ± 0.26mmol/L vs. 1.73 ± 0.28mmol/L, $P<0.01$). Exercise has a significant effect on the serum TG level of athletes ($P<0.01$). Although compared with the non-supplemented group, the amino acid-supplemented athletes also had lower serum TG concentrations (supplemented: 0.94 ± 0.31 mmol/L versus no supplementation: 1.08 ± 0.26 mmol/L), but there was no significant difference. In addition, the statistical results also show that supplementation of amino acids can increase the athlete's serum HDL-C level to a certain extent (supplement: 0.82 ± 0.11 mmol/L, not supplement: 0.76 ± 0.26 mmol/L, but no supplement). Found statistical differences, and it has a significant impact on the serum LDL-C level of athletes ($P<0.01$), and has a significant reduction effect. The relevant data is shown in Figure 2.

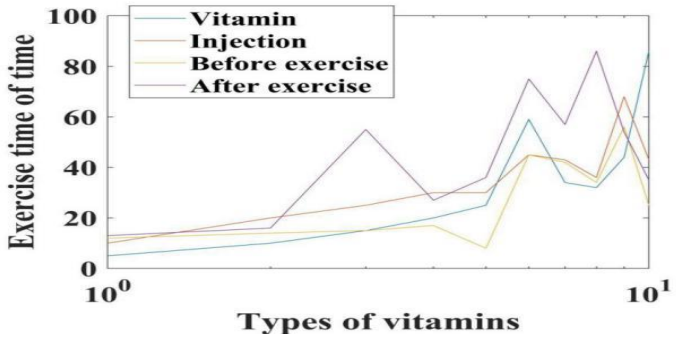

Figure 2. The supplementation of branched-chain amino acids reduced the levels of LDL-C and TG in serum of athletes

It can be seen from the data in Figure 2 that in resistance exercise, supplementing athletes with branched-chain amino acids can effectively reduce athletes' serum LDL-C levels, the reduction effect can reach 25.6%-30%, and the serum TG concentration in the body is also obviously obtained[18-19]. Effective reduction, showing the effectiveness of branched chain amino acids.

4.2. Analysis on the Influence of Supplementing Branched-Chain Amino Acids on Athletes' Hormonal Response in Endurance Sports Training

This experiment showed that 5 hours after exhaustive exercise, 5-HT in the control group reached the peak value and then decreased; the 5-HT in the low-dose and middle-dose groups reached the peak value 6 hours. After exhaustive exercise, the 5-HT of rats in the high-dose group showed a downward trend. It is recommended that BCAA supplementation can delay the onset of fatigue. This indicates that the important cause of central fatigue caused by continuous endurance exercise is the increased release of neurotransmitters. During exercise, the release of serotonin (5-HT, also known as serotonin) was found to be 20% higher than normal. Changes in 5-HT levels can affect sleep, arousal and mood. Increased 5-HT concentration can cause fatigue after exercise. In addition, the number of tryptophan-related hormones transported by athletes during exercise is limited by the transport capacity of the trans blood brain barrier transport carrier, and tryptophan and a large number of other neutral amino acids share the same trans-blood barrier transport system acid (including BCAA). In addition, the T/C ratio in athletes has been changing during exercise, and the T/C ratio in athletes has changed significantly after supplementing branched chain amino acids. The specific data is shown in Figure 3.

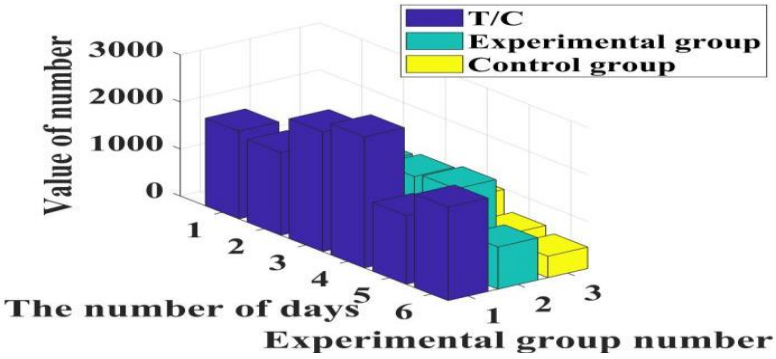

Figure 3. Effects of branched chain amino acids on T/C ratio in athletes

It can be seen from the data in Figure 3 that during long-term exercise, due to changes in the levels of various hormones in the athletes' plasma, the T/C ratio in the body has been increasing.

After exercising for more than 50 minutes, the T/C ratio has increased by 15.6 compared to the normal level. This ratio will increase the fatigue of athletes, but after supplementing low-dose branched chain amino acids, the T/C ratio in athletes will be reduced by about 20%.

In addition, it is found that exercise not only increases the ratio of free tryptophan to branched amino acids (try / BCAAs), but also promotes the transport of tryptophan to the brain and the synthesis of 5-HT, which ultimately leads to central fatigue. Intake of BCAA can increase its plasma concentration to balance the increase in try/BCAA caused by exercise, thereby reducing the synthesis and release of 5-HT and reducing central fatigue. Through experimental comparison, BCAA supplements carbohydrates in different types of continuous exercise. The results show that supplementation of BCAA and carbohydrates can improve the mental agility of athletes. In addition, in some studies, supplementation of BCAA before or during exercise can increase the blood ammonia concentration by 15-17.62%. However, the results are different. The difference may be related to the amount of BCAA supplements. Ingestion of a large amount of BCAA (20-30 g) may result in a higher ammonia concentration, but when the BCAA is relatively small (7-10 g or 100 mg) / no increase in the amount of ammonia released from the muscle has been observed several times. During exercise and intake recovery, this supplement improves plasma BCAA concentration enough to balance exercise and increase the concentration attempted after exercise. Therefore, proper intake of BCAA during long-term exercise will not lead to increased blood ammonia concentration and early fatigue. The relevant data is shown in Figure 4.

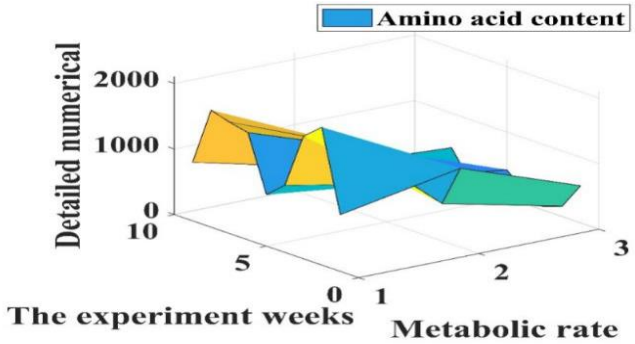

Figure 4. The effect of supplementing branched-chain amino acid on the endurance of athletes

From Figure 4, it can be seen that supplementing endurance training athletes with branched-chain amino acids can not only reduce the decrease in the Try/BCAAs ratio in their bodies, but also increase the blood ammonia hormones, and increase their protein synthesis and metabolism rates by 10%. It can increase the growth hormone in the body by 2.3 index points, which can relieve the athlete's sports fatigue to a large extent.

5. Conclusion

(1) This article analyzes the current problems about the influence of branched-chain amino acid supplementation on certain hormone responses of athletes, and discusses how to solve these problems, and proposes corresponding solutions. The mechanism and mechanism of the influence of branched chain amino acids on the endurance of athletes are introduced, and the mechanism of branched chain amino acids on alleviating sports fatigue of athletes and the related hormones in the athletes' body are studied, and the influence of branched chain amino acids is analyzed. The reaction and changes of related hormones in athletes.

(2) Analyzed the mechanism of supplemental branched chain amino acids studied in this thesis on athletes' resistance to exercise. The experiment found that branched chain amino acids have an

activation efficiency of 75.8% on mTOR factor, which has an effect on protein kinase B and mitogen activated protein kinase. The activation effect of P38 can reach 93.5% and 75%-80.2% respectively. In addition, in resistance exercises, supplementing athletes with branched-chain amino acids can effectively reduce athletes' serum LDL-C levels, and the reduction effect can reach 25.6%-30%. The serum TG concentration in the body can also be effectively reduced.

(3) The influence of supplementation of branched chain amino acids on the body hormone response in endurance sports training of athletes was discussed and verified. Experiments have verified that during time exercise, due to changes in the levels of various hormones in the athletes' plasma, the T/C ratio in the body has been increasing. After exercising for more than 50 minutes, the T/C ratio has increased by about 15.6% compared to the normal level. The ratio will increase the fatigue of athletes, but after supplementing low-dose branched chain amino acids, the T/C ratio in athletes is reduced by about 20%. Moreover, supplementing a certain dose of branched-chain amino acids can also increase the rate of protein synthesis and metabolism in the body by 10%, and increase the growth hormone in the body by 2.3 index points, which can greatly alleviate sports fatigue of athletes.

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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] Park, J. G, Tak, W. Y, Park, S. Y, Kweon, Y. O, Jang, S. Y, & Lee, Y. R. (2017). "Effects of Branched-Chain Amino Acids (Bcaas) on the Progression of Advanced Liver Disease", Medicine, 96(24), pp.6580-6581. https://doi.org/10.1097/MD.0000000000006580

[2] Chen, I. F, Wu, H. J, Chen, C. Y, Chou, K. M, & Chang, C. K. (2016). "Branched-Chain Amino Acids, Arginine, Citrulline Alleviate Central Fatigue After 3 Simulated Matches in Taekwondo Athletes: a Randomized Controlled Trial", Journal of the International Society of Sports Nutrition, 13(1), pp.28-29. https://doi.org/10.1186/s12970-016-0140-0

[3] Sakamaki-Sunaga, M, Kamemoto, K, Yamada, M, Matsuda, T, & Ogata, H. (2019). "Effects of Menstrual Cycle on Branched-Chain and Aromatic Amino Acids During Endurance Exercise in Female Athletes: 2025 Board #181 May 30 2:00 Pm - 3:30 Pm", Medicine & Science in Sports & Exercise, 51(7), pp.547-548. https://doi.org/10.1249/01.mss.0000562143.85569.ac

[4] Kita, K, Ito, K. R, Sugahara, M, Kobayashi, M, Makino, R, & Takahashi, N. (2015). "Effect of in Ovo Administration of Branched-Chain Amino Acids on Embryo Growth and Hatching Time of Chickens", Journal of Poultry Ence, 52(1), pp.34-36. https://doi.org/10.2141/jpsa.0130208

[5] Yan, P, Luo, J, & Sun, X. (2016). "Review on Application Prospects of Nutritional Supplement Branched-Chain Amino Acids in Competitive Sports", Advance Journal of Food Ence and Technology, 12(5), pp.251-256. https://doi.org/10.19026/ajfst.12.2907

[6] Kawaguchi, Nagao, Abe, Imazeki, Honda, & Yamasaki. (2015). "Effects of Branched-Chain

Amino Acids and Zinc-Enriched Nutrients on Prognosticators in Hcv-Infected Patients: a Multicenter Randomized Controlled Trial", Molecular Medicine Reports, 11(3), pp.2159-2166. https://doi.org/10.3892/mmr.2014.2943

[7] Morales, A, Arce, N, Cota, M, Buenabad, L, Avelar, E, & Htoo, J. K. (2015). "Effect of Dietary Excess of Branched-Chain Amino Acids on Performance and Serum Concentrations of Amino Acids in Growing Pigs a. Morales, n. Arce, m. Cota, l. Buenabad, e. Avelar1, j. k. Htoo and m. Cervantes", J Anim Physiol a Anim Nutr, 100(1), pp.39-45. https://doi.org/10.1111/jpn.12327

[8] Osorio, J, & Donoso, H. (2017). "Effects of a Competitive Triathlon on Plasma Concentrations of Tryptophan and Branched-Chain Amino Acids", Rev.Paul.Educ.Fís, 7(2), pp.3-4. https://doi.org/10.11606/issn.2594-5904.rpef.1993.138750

[9] Yan, P, Luo, J, & Sun, X. (2016). "Review on Application Prospects of Nutritional Supplement Branched-Chain Amino Acids in Competitive Sports", Advance Journal of Food ence & Technology, 12(5), pp.251-256. https://doi.org/10.19026/ajfst.12.2907

[10] A. Ruiz-Margáin, R.U. Macías-Rodríguez, S.L. Ríos-Torres, B.M. Román-Calleja, O. Méndez-Guerrero, & P. Rodríguez-Córdova. (2018). "Effect of a High-Protein, High-Fiber Diet Plus Supplementation with Branched-Chain Amino Acids on the Nutritional Status of Patients with Cirrhosis", Revista de Gastroenterología de México (English Edition), 83(1), pp.9-15. https://doi.org/10.1016/j.rgmxen.2017.02.005

[11] Sheikholeslami-Vatani, D, & Ahmadi, S. (2016). "Effect of Oral Branched-Chain Amino Acid Supplementation Prior to Resistance Exercise on Metabolic Hormones, Plasma Amino Acids, and Serum Indices of Muscle Damage in the Recovery Period", Topics in Clinical Nutrition, 31(4), pp.346-354. https://doi.org/10.1097/TIN.0000000000000085

[12] A., R, Agrawal, N, Kumar, H. , & Kumar, V. (2018). "Emerging Role of Branched Chain Amino Acids in Metabolic Disorders: a Mechanistic Review", Pharmanutrition, 6(2), pp.47-54. https://doi.org/10.1016/j.phanu.2018.01.003

[13] Qiu jun, zhou dong, he yilei, xu zhongqi. (2016). "Progress in Studies on the Effects and Safety Mechanisms of Supplementary Branched Chain Amino Acids on Athletes in Different Sports", Sports Science and Technology, 37(6), pp.88-92.

[14] Tang fang, zhang yunkun. (2012). "Research Progress on the Effect of Supplementary Branched Chain Amino Acids on Athletic Ability", Journal of Nanjing University of Physical Education (Natural Science Edition), 11(2), pp.150-152.

[15] Xia Z, Liu Y, Xia Q X, SHU Z L, Chen Y M. (2006). "Relationship Between Branched Chain Amino Acids and Exercise", Journal of Capital Institute of Physical Education, 2006(2), pp.125-128.

[16] Mahmoud Miari , Mohamad Taher Anan , Mohamed Bisher Zeina, Neutrosophic Two Way ANOVA, International Journal of Neutrosophic Science, 2022, Vol. 18, No. 3, pp: 73-83. https://doi.org/10.54216/IJNS.180306

[17] Rout, R.; Parida, P.; Alotaibi, Y.; Alghamdi, S.; Khalaf, O.I. Skin Lesion Extraction Using Multiscale Morphological Local Variance Reconstruction Based Watershed Transform and Fast Fuzzy C-Means Clustering. Symmetry 2021, 13, 2085. https://doi.org/10.3390/sym13112085

[18] Choi, G. H. , Ko, H. , Pedrycz, W. , Singh, A. K. , & Pan, S. B. . (2020). Recognition system using fusion normalization based on morphological features of post-exercise ecg for intelligent biometrics. Sensors, 20(24), 7130. https://doi.org/10.3390/s20247130

[19]H. Song and M. Brandt-Pearce, "A 2-D Discrete-Time Model of Physical Impairments in Wavelength-Division Multiplexing Systems," in Journal of Lightwave Technology, vol. 30, no. 5, pp. 713-726, March1, 2012. doi: 10.1109/JLT.2011.2180360