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Research Article

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Experimental research into the effect of albumin on relieving exercise-induced fatigue

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ABSTRACT

physiological mechanism of albumin's effect on relieving the exercise-induced fatigue is discussed. Method: 24 university students that have the habits of doing exercises are at random classified into an observation group and a control group, and each group consists of 12 students. Before doing exercises, the observation group is supplied with drink containing albumin, and the control group is supplied with purified water; both groups do the same exercises of the same strength. Results: the control group members' hemoglobin level significantly falls (P<0.05); the hematocrit(HCT) is significantly improved (P<0.05), however, there is no significant difference with the members from the observation group (P>0.05); the change in the main blood biochemical indexes of the control group members after the experiment is as follows: the level of Creatine Kinase (CK) and serum urea nitrogen(BUN) rises significantly (P<0.05), and the difference in the concentration of blood lactate(Bla) is very significant (P<0.01) and the blood sugar falls slightly (P<0.05). Conclusions: Frequent supplementation of nutrient drinks may effectively resist fatigue arising from exercises.

Keywords: Albumin; Exercise-induced Fatigue; Relieving

INTRODUCTION

Exercises-induced fatigue means that an organism's function cannot be maintained at a specific level during its physiological process or the organism bodies cannot maintain a predetermined exercise strength and feel unadapted. When the exercise load goes beyond the limit of an organism, physiological functions fade temporarily. Fatigue is a common physiological phenomenon, and the physiological function will surely change when exercises are done to an extent. Should exercise-induced fatigue not be immediately relieved and overfatigue take place or exercise-induced fatigue not be adjusted in time and exercises continue, the fatigue will be exacerbated, thus causing exhaustion. In this way, exercise-induced fatigue becomes a pathological phenomenon, and negative effect is exerted on the health. It is necessary that objective method is adopted to test the fatigue according to the pathogenesis, by which the fatigue is caused; some methods for reliving exercise-induced fatigue are used so that the organism may be effectively recovered quickly to reach a higher exercise capability. Supplementation of nutrition may relieve exercise-induced fatigue effectively.

Protein, as a raw material for repairing and growing organism tissues, plays an important role in relieving fatigue after exercises and improving the capability of doing exercises[1]. So the sportsmen shall pay attention to supplementation of protein. According to nutritionists, during exercises, more protein is needed to prolong exercise-induced fatigue or construct muscles[2]. Accordingly, in some developed countries, drink containing albumin is often consumed by people doing exercise as the drink is both simple and delicious.

Albumin is a kind of high quality protein that is valuable for its nutrition in milk, is rich in all of necessary amino acids and contains several kinds of bioactive substance, and its constitution model is similar to that of human

bodies[3]. With the development and application of milk product processing technologies, whey protein concentrate (WPC) and whey protein isolate (WPI) have been widely applied in exercise nutrients, and are good sources for supplementing high quality protein for sportsmen. Albumin has high nutrition values. In this research, albumin is used as the materials for the experimentation to demonstrate the relationship between the albumin and the exercise-induced fatigue by using albumin in exercise experiment. This experiment is to provide theoretical basis for preventing or relieving the exercise-induced injuries of the people that often do exercises.

EXPERIMENTAL SECTION

1.1 Materials

The albumin powder that the subjects take is Kang Bite pure whey protein powder (packed in bottle, 750g) produced by Beijing Kang Bite Sports Technology Co., Ltd, and the purified water that the subjects take is WAHAHA purified water produced by Hangzhou WAHAHA Group.

1.2 Instrument and Equipment

BTX-1800 Hemocyte Analyzer is produced by Zibo Hengtuo Analysis Instrument Co., Ltd; 752 ultraviolet grating spectrophotometer is produced by Third Analysis Apparatus Company of Shanghai; TDL-40B low temperature high speed centrifuge is produced by Shanghai Zhong'an Medical Instrument Company; and ultra-low temperature refrigerator is produced by Thermo Company of USA.

1.3Subjects

24 male college students that have the habit of doing exercises from Hefei are selected and tested for eight weeks. They are classified into a testing group (12 students) and a control group (12 students) at random The average age of the control group is 19.12±2.44 years old and its average weight is 67.65±11.68kg with the average height of171.62±9.31cm; the average age of the observation group is 20.01±2.65 years old with its average with its weight of 66.90±10.02kg and average height of 172.46±10.07cm. There is no significant difference in the ages, weight and height between the two groups in this experiment through statistical processing.

1.4 Experimental method

1.4.1 Mode for supplementing the drink and quantity of drink

During the experimentation, the members from the observation group drink 300-500ml of WAHAHA purified water (including 30g of albumin powder) within one hour before and after doing exercises every day, and are supplied with about 200 ml of WAHAHA purified water (containing 20g of albumin powder) one hour before going to bed. The members of the control group are supplied with equivalent quantity of purified water simultaneously as the testing group does; the test duration is about 12 weeks. All of subjects must have meals at the students' dining rooms without additional nutrition supplements.

1.4.2 Subjects' modes of doing exercises and quantities of exercises during the test

The subjects from the two groups have to complete the same sports, including 30 minutes' treadmill, 3 minutes' push-up, and 3 minutes' sit-up and then the sports are repeated once again. During jogging, the optimum heart rate zone shall be calculated firstly; the calculation method of the optimum heart rate zone: upper limit of heart rate=220-the current age*0.8; the lower limit of heart rate=220-the current age*0.6. For instance, a subject is 20 years old, the optimum heart rate fluctuation zone during exercise is 120-160 heart bits per minute.

During the experimentation, the subjects are informed that the heart rate shall not exceed its maximum heart rate:220-age, or else, the heart rate shall be reduced immediately to its normal rate to avoid accidents.

1.4.3 Testing and method of indices

1.4.3.1 Sampling

On the last day of the 12th week, the subjects from the two groups start to do exercises 5 min after making preparations, and 3ml venous blood is sampled 3 minutes after doing exercises; heparin is used for anticoagulation, the blood is centrifugalized at a low speed and serum is taken and then refrigerated for testing.

1.4.3.2 Blood routine examination

BTX-1800 Hemocyte Analyzer is used for measuring the number of red blood cells (RBC), concentration of hemoglobin(HB), HCT and mean volume of red cells in the blood (MCV) before and after doing the exercises.

1.4.3.3 Measurement of concentration of blood lactate(BLB)

Improved Barker-Summerson method is used.

1.4.3.4 Blood urea nitrogen(BUN) and Creatine Kinase (CK)
Microcolorimetry is used for measuring the content of BUN, and CK-NAC coupled UV double assay kit method is used for measuring CK. The assay kits are purchased from Shanghai Yulan Bio-tech Co., Ltd, and strictly follow the specifications of the assay kit.

RESULTS AND DISCUSSION

2 Experimental results
2.1 Influence of albumin supplemented on the constituents of the subjects' blood
According to the research results, through 12 weeks' experiment, the main indices of the blood constituents of members from the control group before and after doing exercises are changed as follows: the level of HB significantly falls (P〈0.05); HCT significantly rises (P<0.05); there is no significant change in the number of red cells and the mean volume of red cells (MVC) (P>0.05). The indices of the blood of the subjects from the experimental group (supplied with albumin) before and after doing exercises are changed as follows: the level of HB, the number of RBC and the mean volume of red cells (MVC) are not significantly changed (P>0.05); however, HCT significantly rises (P<0.05). Refer to Table 1.

Table 1 Comparison of Blood Constituents of the Two Group Members Before and After the Experiment
（x ± s, n=12)

Group	Testing stage	HB(g/l)	RBC(1012 /l)	HCT(%)	MVC(fl)
Control group	Before	135.9 ± 2.56*	4.37 ± 0.36	30.46 ± 2.83*	71.61 ± 1.19
	After	129.1 ± 1.21	4.31 ± 0.83	35.02 ± 1.32	70.98 ± 1.06
Observation group	Before	136.0 ± 5.02	4.14 ± 2.61	30.72 ± 0.44▲	70.38 ± 2.07
	After	139.7 ± 6.21	4.02 ± 0.26	34.88 ± 2.05	71.21 ± 1. 38

*Note: * Comparison of the control group before and after the experiment P<0.05; ▲Comparison of the observation group before and after the experiment P>0.05.*

2.2 Change of the subjects' biochemical indices from the two groups before and after the experiment
According to the research results, through 12 weeks' experiment, the main biochemical indices of the blood constituents of members from the control group before and after the experiment are changed as follows: the level of CK and BUN significantly rises (P<0.05); the level of blood sugar significantly falls (P<0.05); the concentration of Bla significantly rises (P<0.01). The biochemical indices of the members from the observation group before and after doing exercises are changed as follows: neither CK nor BUN is significantly changed. The concentration of Bla significantly rises though (P<0.05), not as significantly as the control group does. Refer to Table 2.

Table 2 Comparison of Biochemical Indices of the Two Group Members Before and After the Experiment
（x ± s, n=12)

Group	Testing stage	Bla(mmol/l)	CK	BUN	Blood sugar (mmol/1)
Control group	Before	2.49 ± 0.56	303.78 ± 75.20	3.03 ± 0.51	4.12 ± 0.28
	After	9.37 ± 1.14**	378.21 ± 52.85*	3.60 ± 0. 93*	3.98 ± 0.88*
Observation group	Before	2.50 ± 0.19	301.12 ± 79.32	3.05 ± 0.44	4.21 ± 0.54
	After	5.91 ± 1.20▲	306.29 ± 71.45	3.08 ± 0.59	4.37 ± 0.83

*Note: * Comparison of the control group before and after the experiment P<0.05; **Comparison of the control group before and after the experiment P<0.01; ▲Comparison of the observation before and after the experiment, P>0. 05*

3. Analysis and Discussion
Seen from Table 1, during exercises, the level of hemoglobin can be prevented from significantly falling and the functions of red cells in the blood of the organisms doing exercises may be maintained by supplementing drink containing albumin. The main reasons are as follows: β-lactoglobulin in the albumin contains a lot of cysteine; α-Lactalbumin, serum protein and lactoferrin contain cystine residue, which becomes two cysteine residue after entering cell membrane, thus improving the concentration of cysteine inside the cells, helping to compound reduced glutathione and improve the content of GSH inside cells; reduced glutathione is the most important antioxidant in cells and its active groups are hydrosulfide groups-SH on cysteine residue, which plays a role as reducer to prevent cells from being oxidized or injured. So the level of GSH in the blood and the organisms' abilities to do exercises may be improved and the occurrence of fatigue may be postponed by supplementing albumin[4].

Seen from Table 2, the concentration of Bla in the members' bodies of the control group after doing exercises rises significantly (P<0.01), however, that of the testing group members (P<0.05) does not rise as significantly as that of the control group members, which means that the skeletal muscle's aerobic capacity because the human bodies' metabolism is improved during exercise, and the catabolism of protein and amino acids is also improved and the gluconeogenesis of amino acids is improved. On the other hand, a lot of free radicals are generated, increasing

oxidative stress, causing injury to muscle cells and decomposition of muscle protein, thus causing muscle fatigue[5]. Protein is the main constituent of muscle, and exerts great influence on the growth and metabolism of muscles and the repair of injured muscles. The protein as a material to repair and upgrade tissues plays an important role in relieving fatigue after doing exercises. Albumin is the richest source of branched-chain amino acid, and may provide substance for aerobics while long-term exercises, reduce the decomposition of muscle protein, and promote the anabolism of protein during recovery after doing exercises, accelerate the composition of muscle protein and improve the capacity of doing exercises. Skeletal muscles are important sites for branched-chain amino acid which transfers the amino groups to the pyruvates to generate alanine which enters the livers to generate glucose through gluconeogenesis, and then the glucose returns to the process of metabolism in muscles which is called "glucose-alanine circulation" [6]. In this way, the concentration of pyruvate inside muscle cells rises and the quantity of lactate generated, which may help to prolong the fatigue.

Seen from Table 2, the concentration of blood sugar of the members from the control group significantly falls ($P<0.05$). However, the concentration of blood sugar of the members from the observation group rises after the experiment ($P>0.05$), which means the level of blood sugar may be maintained stable by supplementing albumin during exercises, however, the level of blood sugar of the control group members that are not supplied with albumin falls.

CONCLUSION

Albumin is a kind of desirable nutritional food that may improve the organisms' ability to resist oxidation, reduce the accumulation of lactate in bodies, and maintain the level of blood sugar stable, accelerate the recovery of physical ability after doing exercises, thus prolonging the occurrence of exercise-induced fatigue or relieving the exercise-induced fatigue.

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