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Supplement of liquid nutrient for fatigue recovery after tennis

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Summary. *Objective:* The objective of this study is to study the relief effect of liquid nutrient containing whey protein on fatigue of tennis players caused by plenty of exercises. *Methods:* Twenty research subjects were randomly divided into a pure water group (n = 10) and a whey protein group (n = 10), and they took tennis training after taking same dose of pure water and whey protein. The weight and fat-free weight of the players were measured before and after experiment. The red blood cells (RBC), hemoglobin (HB), blood lactic acid (BLA) and creatine kinase (CK) were detected through blood sampling. *Results:* After experiment, the fat-free weight of the whey protein group was significantly higher than that of the pure water group ($P < 0.05$), the RBC and HB of the whey protein group were higher ($P < 0.05$), and the BLA and CK of the whey protein group were lower ($P < 0.05$). *Conclusion:* The supplement of whey protein liquid nutrient is beneficial to promoting the generation of RBC and HB, reducing lactic acid accumulation, and inhibiting the increase of serum creatine phosphokinase, which is helpful to the recovery of exercise induced fatigue.

Key words: whey protein, liquid nutrient, tennis, exercise-induced fatigue, hemoglobin

Introduction

Tennis requires high on the physical ability and spirit of athletes. To maintain a high competitive level, tennis players need to do long-time and high-intensity training. Under such training, athletes usually have exercise-induced fatigue. Exercise-induced fatigue refers to a phenomenon of being unable to maintain exercise at a fixed intensity (1), which will not only affect exercise performance, but also increase the risk of excise-induced injury (2). Reasonable intake of liquid and dietary nutrients is conducive to supplementing nutrients in athletes and promoting fatigue recovery. The main research object of this study is the liquid nutrient added with whey protein. Whey protein, as a kind of high-quality protein, has been widely used in food. Through the study of 18 athletes, Hansen et al. (4) found that whey protein intake could effectively improve athletes' performance and reduce sports injury. Junior et al. (5) studied 31 old women and divided them into two groups. The two groups were given whey protein and placebo respectively. The results showed that the quality of skeletal muscle of women taking whey protein was significantly improved, and the quality of muscle was also improved. Aiming at the problem of muscle injury of football players, Philpott et al. (6) studied the effects of whey protein beverage on athletes and found that the beverage could effectively improve the muscle soreness of athletes and inhibit the increase of creatine kinase. Taking rats as the research subjects, Ren et al. (7) studied the effects of whey protein on the performance of long-term training arc in rats and found that whey protein supplement could improve the fatigue time of rats, reduce the content of propylene glycol, and relieve exercise-induced fatigue. Taking 20 tennis players as the research subjects, this study analyzed the fatigue recovery effect of whey protein liquid nutrient intake on tennis athletes after a period of tennis exercise and proved the fatigue recovery effect of whey protein by comparing blood routine and blood biochemical indicators, which is beneficial to the application and promotion of whey protein liquid nutrient in practice.

Whey protein

Whey protein, a kind of protein extracted from milk (8), contains more than 20 kinds of amino acids and can promote muscle glycogen renewal and supplement energy. Moreover it has a variety of functional active substances. In the process of sports, lack of protein will cause negative nitrogen balance, which is not conducive to the recovery of fatigue after exercise. Therefore, athletes need to timely supplement high-quality protein (9). Movement protein has characteristics of easy to absorb, rich nutrition and low cholesterol and fat. Whey protein can meet the needs of human protein supplementation and is conducive to increase muscle (10) and improve immunity. In this study, the exercise-induced fatigue recovery effect of liquid nutrients made of whey protein was studied. The formula of the liquid nutrient used is shown in Table 1.

Materials and methods

Research subjects

Twenty students were randomly selected from the athletes who were from the male tennis team of physical culture institute of Xi'an University of Architecture and Technology, China, and volunteered to attend experiment and signed informed consent. They were divided into a whey protein group and pure water group. The general information of the athletes is shown in Table 2.

Table 1. Whey protein liquid nutrient

Whey protein	3%
Saccharos and oligosaccharide	3.5%
Acidulant	2%
Carboxymethylcellulose	0.15%
Salt	1.2%
Water	90.15%

Table 2. Comparison of general information of the research subjects

	Whey protein group (n=10)	Pure water group (n=10)
Age	21.86 ± 1.27	21.55 ± 1.36
Height/m	171.24 ± 6.74	172.68 ± 5.39
Weight/kg	64.59 ± 7.12	63.27 ± 8.65
Training time/year	3.57 ± 0.52	3.61 ± 0.47

Experimental methods

The two groups of athletes received the same training task every day. Under the guidance of the coach, they were trained twice a day for tennis, 2 hours each time. The whey protein group took 400 ml of whey protein liquid nutrient half an hour before training, half an hour after training and half an hour before sleeping, while the pure water group took 400 ml of pure water at the same time. The experiment lasted for seven days, and the venous blood was collected before and after training at the first, fourth and seventh day. During the experiment, the athletes of the two groups had unified meals and did not take any extra nutrients.

Measurement indicators

Basic indicators including weight and fat-free weight were detected by research staffs before and after experiment.

Blood routine indicators including red blood cells (RBC) and hemoglobin (HB) were detected by sending blood samples to Xi'an hospital.

Serum biochemical indicators including blood lactic acid (BLA) and creatine kinase (CK) were detected by sending blood samples to Xi'an hospital.

Statistical analysis

The data were recorded in Excel 2007 and statistically analyzed using SPSS. 17.0. Different indicators were expressed in the form of mean ± standard deviation ($\overline{X} \pm S$) and processed by t test. Difference was considered as statistically significant if the value of P was smaller than 0.05.

Experimental results

Changes of basic indicators

As shown in Table 3, the weight and fat-free weight of the athletes in the two groups had no significant differences before experiment; the weight of the two groups decreased after experiment ($P < 0.05$), but the fat-free weight increased. The fat-free weight of the whey protein group was 50.84 ± 2.27 kg be-

Table 3. Comparison of basic indicators

		Pure water group	Whey protein group
Weight/kg	Before experiment	63.27 ± 8.65	64.59 ± 7.12
	After experiment	62.36 ± 6.78*	62.45 ± 6.64*
Fat-free weight/kg	Before experiment	51.27 ± 3.12	50.84 ± 2.27
	After experiment	51.42 ± 3.34	53.67 ± 3.12*#

Note: * indicated P < 0.05 compared to before experiment; # indicated P < 0.05 compared to the pure water group.

fore experiment and 53.67 ± 3.12 kg after experiment, showing a significant increase and a significant difference with the pure water group (P < 0.05). The experimental results demonstrated that the intake of whey protein liquid nutrient could effectively reduce body fat rate and promote growth of muscle.

Changes of RBC

It was found from Figure 1 that the RBC level of both groups decreased after training. At the seventh day, the RBC level of the pure water group and whey protein group was 4.94 ± 0.33 × 10^{12}/L and 4.96 ± 0.32×10^{12}/L respectively before training, and there was no significant difference. After training, the RBC level of the pure water group decreased to 4.61 ± 0.27 × 10^{12}/L, and the RBC level of the whey protein group was 4.84 ± 0.26 × 10^{12}/L, which was significantly higher (P < 0.05).

Changes of HB

It was found from Figure 2 that the HB of the two groups had no remarkable difference before training, but the HB showed a decreasing tendency in both groups after training. At the seventh day, the HB of the pure water group decreased to 131.57 ± 7.62 g/L, and the HB of the whey protein group decreased to 138.49 g/L, showing that the HB of the pure water group decreased more, but the difference had no statistical significance (P > 0.05). The change of HB demonstrated that the intake of whey protein liquid nutrient could inhibit the decrease of HB, which was beneficial to the fatigue recovery of athletes.

Changes of BLA

It was found from Figure 3 that the BLA level of the athletes in the two groups had significant increase after training (P < 0.05). At the seventh day, the BLA level of the pure water group increased to 3.62 ± 1.98 mmol/L, and that of the whey protein group increased to 1.83 ± 1.54 mmol/L after training, which was significantly lower than the pure water group (P < 0.05). It indicated that the intake of whey protein liquid nu-

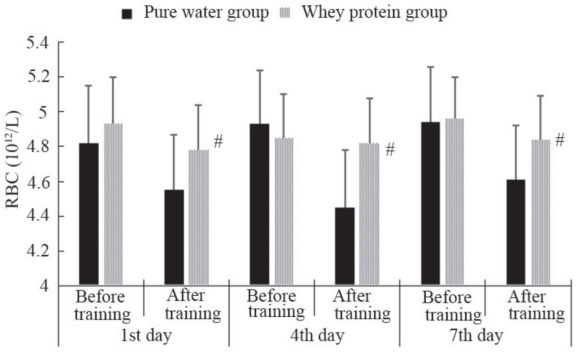

Figure 1. The changes of RBC
Note: #: P < 0.05 compared to the pure water group.

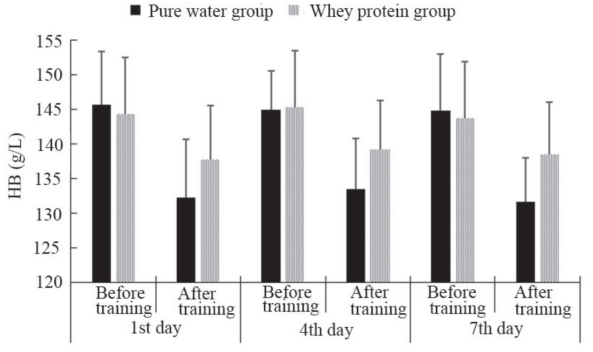

Figure 2. Changes of HB

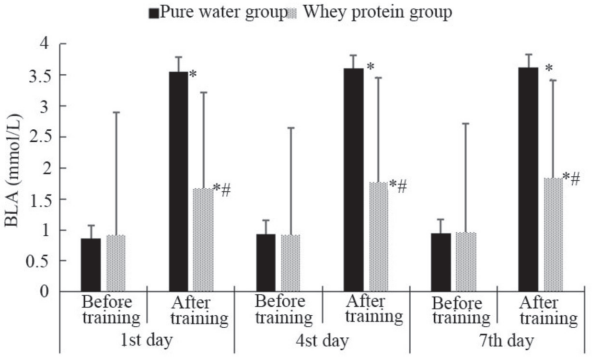

Figure 3. Changes of BLA
Note: * means P < 0.05 compared to before training; # means P < 0.05 compared to the pure water group.

trient could reduce the generation of BLA in bodies of athletes to relieve fatigue.

Changes of CK

It was found from Figure 4 that the CK level of the pure water group showed a significant difference before and after training ($P < 0.05$). At the seventh day, the CK level of the pure water group was 142.36 ± 71.64 U/L, and that of the whey protein group was 109.21 ± 52.77 U/L respectively after training, which was significantly lower than that of the pure water group ($P < 0.05$).

Discussion

As the second largest ball game in the world, tennis has developed rapidly in China. Tennis players need long-term and high-intensity tennis training in order to achieve a higher level of competition. In tennis, the physical energy consumption of athletes is very huge. Simple massage and sleep are not enough for athletes to recover. The nutrients consumed in tennis need to be supplemented in time to help tennis players recover their physical fitness. For tennis players, it is necessary to supplement some foods with high sugar, low fat and high protein.

Fat-free weight can reflect the body's adaptability to training, and its increase has a role in enhancing athletes' strength, explosive force, endurance, etc. Athletes need to maintain the best muscle mass in order to achieve better performance (11). It was found from Table 3 that the fat-free weight in the whey protein group was significantly higher than that in pure water group ($P < 0.05$), indicating that whey protein component could effectively increase the fat-free weight (12), reduce fat, and enhance the energy reserves.

In the process of human exercise, oxygen is transported through blood, mainly affected by RBC and HB. When RBC and HB decrease, the ability of oxygen transport decreases, and the human body will experience fatigue. The production of RBC and HB requires a lot of nutrients. If there is no additional supplement, RBC and HB will be reduced, so that the body's physical fitness will decline and exercise fatigue will occur. It was found from Figure 1 and 2 that the RBC and HB of the two groups showed a downward trend after experiment, and the descending range of the pure water group was significantly larger than that of the whey protein group, which indicated that whey protein component had a role in promoting the reduction of RBC and HB. Increasing the number of RBC and HB is conducive to maintaining the acid-base balance in the body, increasing the amount of exercise oxygen, and thus promoting the recovery of exercise-induced fatigue.

With the accumulation of fatigue, lactic acid accumulation will occur in the body; the more lactic acid accumulation, the more prominent the muscle soreness symptom. The content of BLA can reflect the metabolic changes and fatigue of the body (13). Whey protein component is beneficial to enhance the body's antioxidant activity and inhibit lactic acid. It was found from the results of Figure 3 that the accumulation of BLA of the whey protein group was better than that of pure water group, which proved that whey protein component could promote fatigue recovery through inhibiting BLA.

CK is an enzyme that regulates cell energy conversion (14). Its activity is closely related to muscle discomfort after exercise. High-intensity training can lead to the increase of CK. It was found from the results of Figure 4 that the CK level of both groups increased after the experiment, the CK level of the pure water group increased significantly compared with that before experiment, but the increase of the whey protein group was less ($P < 0.05$). It showed that whey protein could effectively inhibit the increase of CK after exercise, proving its role in fatigue recovery.

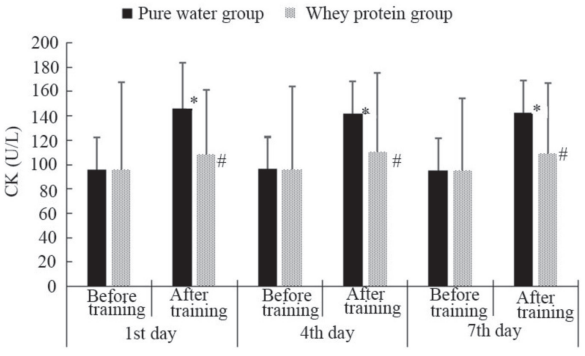

Figure 4. Changes of CK
Note: * indicated $P < 0.05$ compared to before training; # indicated $P < 0.04$ compared to the pure water group.

This study confirmed the fatigue recovery role of whey protein liquid nutrient. In the next step, we will further study liquid nutrients at different dosage and formulations.

Conclusion

In the present study, the effect of supplementation of whey protein liquid nutrients on the recovery of fatigue after tennis was studied. By comparing the indicators of the pure water group and whey protein group such as RBC and HB, it was found that:

1) after training, the weight of the athletes in both groups increased, and the whey protein group increased more;
2) the decrease of erythrocyte and hemoglobin in the whey group was lower than that in the pure water group;
3) the level of serum lactic acid produced in the whey group was significantly lower than that in the pure water group;
4) the increment of CK in the whey protein group was significantly lower than that in the pure water group.

In conclusion, whey protein liquid nutrients are beneficial to the formation of RBC and HB and can effectively inhibit the increase of BLA and CK, thereby relieving fatigue. This work makes some contributions to the study of fatigue recovery of athletes.

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