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Comparison of application of various anti-fatigue nutritional beverages in supplementing function of basketball players

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Summary. Basketball, as a high-intensity and high-risk sport, requires athletes to maintain a high level of physical function at all times. In recent years, with the rapid development of food manufacturing technology, a variety of anti-fatigue nutritional beverages for athletes emerge one after another. Therefore, the application of a variety of anti-fatigue nutritional beverages in supplementing the different physical function needs of basketball players has become a key topic in sports health research. In this study, basketball players were selected as experimental subjects, and the control group was set up. Three kinds of anti-fatigue nutritional beverages, namely sugar beverage, taurine beverage and tea beverage, were tested to understand the different application of different nutritional beverages in supplementing function, so that basketball players can better maintain physical strength and improve sports performance. Through the comparison of the experimental results, it is concluded that sugar beverage has the greatest application degree to blood lactic acid, taurine beverage has the greatest application degree to liver glycogen content and tea beverage has the greatest application degree to serum urea. Therefore, in practical application, attention should be paid to the coordination of various nutritional beverages and different beverages should be drunk according to the actual needs.

Keywords: anti-fatigue nutritional beverage; basketball players; physical function

Introduction

With the development of basketball, the number of basketball players is increasing day by day. However, in order to achieve good results on the court, the maintenance of physical function is the most basic bargaining chip to continue to compete. Exercise-induced fatigue is a manifestation that the human body cannot maintain the fixed exercise intensity(1), which may induce decline of exercise performance and increase risks of injuries (2). At present, basketball players mainly rely on anti-fatigue nutritional drinks to supplement the lack of physical function in a short period of time. Therefore, the functional application of different kinds of anti-fatigue food is a hot topic. Xia et al. (3) divided okra pods into seeds and skin and compared the effects of seeds (OSD) and skins (OSK) *in vivo* and *in vitro*. It was proved that the ingredients contained in okra had antioxidant and anti-fatigue functions. Di et al. (4) observed the anti-fatigue effect of small molecular oligopeptides isolated from *Panax quinquefolium L.* on mice and proved that the anti-fatigue effect of *Panax quinquefolium L.* was attributed to ginsenosides and oligopeptides. Zhao et al. (5) found that the water extract from Caulis Spatholobi had an anti-fatigue effect. The extract was further separated by alcohol precipitation method, and finally the total polysaccharide was proved to be the reason that Caulis Spatholobi could increase the level of glucose and make it have anti-fatigue effect. Li et al. (6) determined the optimal extraction conditions of Maca polysaccharide by response surface method, and discussed the anti-fatigue activity of Maca polysaccharide by using model prediction. The results of swimming parameters and biochemical parameters showed that the low dose Maca polysaccharide group had significant anti-fatigue activity. During exercise, basketball players lose a lot of water and electrolytes due to excessive sweating. Nu-

tritional beverages can provide energy for the body conveniently and quickly, and alleviate its discomfort. Functional ingredients in beverages can improve athletes' reaction level and accelerate the recovery of limb fatigue (7). The current study mostly concerns the influence of one kind of anti-fatigue food on functions of human body, but seldom concerns about the comparison of different foods. Therefore, based on physiological principle, three kinds of anti-fatigue beverages were tested in this study. The experimental data of blood sugar, hepatic glycogen and blood lactic acid in body function after drinking nutritional beverage were compared by random sampling method, and different application situations were obtained.

Causes for fatigue of basketball player

In addition to the big moves such as fast running, avoiding and leaping in the game, basketball players also need to consume a lot of energy in the daily training after the game. In this way, the alternating sport on and off the court makes the athletes easily fall into physical fatigue. The causes of fatigue of basketball players can be divided into two categories.

(1) Exercise fatigue (8). In basketball matches, there is often a continuous competition between the two sides for a certain time and several rounds. In this process, athletes need to constantly change the way of dribble and switch different technical movements. It makes the muscles of athletes constantly relax and stretch. At this time, the PH value in the body decreases, and the activity of active enzymes in the muscles is inhibited, leading to the insufficient regeneration rate of available energy of the human body and the phenomenon of fatigue. Drinking nutritious beverages can generally alleviate this situation.

(2) Injury fatigue (9). Due to the heavy training and competition intensity of basketball players, the wear and tear of each joint is more serious, so many athletes are plagued by injuries. Common injuries include Achilles tendon rupture, knee swelling and so on. The sequelae of injuries and illnesses lead to the decline of immunity, which makes it difficult for the body to recover quickly. It makes the injured parts easily fatigued after excessive exercise and unable to undertake the next intense exercise. Some anti-fatigue nutritional beverages contain certain pain-relieving ingredients, such as caffeine. But drinking nutritious beverages is only a palliative for athletes who are tired from injuries and diseases.

Experiment

Laboratory reagents

Laboratory reagents included blood sugar determination reagent, liver glycogen determination reagent and lactic acid determination reagent.

Experimental materials

To simulate the main types of anti-fatigue nutritional beverages in the market, three groups of compound beverage samples were prepared in proportion, and a control group was set up. The amount of each sample in each group was 300 ml, and the temperature, humidity and other conditions were the same. All four groups of experiments were conducted at the same time on the same day. The experimental conditions of each group were as follows:

Control group: 100% pure water.

Group 1 (Sugar beverage group): 8% carbohydrate, 0.4% taurine, 1% theanine, 5% vitamin B, 0.3% L-lysine hydrochloride, 0.015% inositol, and 0.01% nicotinamide. The rest was pure water.

Group 2 (Taurine beverage group): 4% carbohydrate, 0.8% taurine, 1% theanine, 5% vitamin B, 0.3%L-lysine hydrochloride, 0.015% inositol, and 0.01% nicotinamide. The rest was pure water.

Group 3 (Tea beverage group): 4% carbohydrate, 0.8% taurine, 2% theanine, 5% vitamin B, 0.3%L-lysine hydrochloride, 0.015% inositol, and 0.01% nicotinamide. The rest was pure water.

Experimental subjects

In a basketball team of some city, 40 male basketball players with no disease or joint injury were randomly selected, aged 20-25 years. All of them signed informed consent. All the players took part in basketball matches more than five times. The average training time was longer than 8 hours per week. At the end of the experiment, the experimental data were obtained according to the blood test results.

Experimental steps

1. Experimental preparation

The subjects were not allowed to consume any beverage containing the ingredients of this study before the start of the study. Subjects maintained good health and avoided strenuous activity. Forty subjects were randomly divided into four groups, ten in each group and drank 400 ml of water on an empty stomach one hour before the formal experiment.

2. Experiment

High-intensity continuous shooting training with 70% VO2max intensity was conducted for 1 hour. At the 0^{th}, 15^{th} and 45^{th} min, solution was supplemented to each person in the corresponding group, 100 ml each time. The physical indicators of the subjects were monitored in real time. A timer was used to measure the exhaustion time of each athlete's shot, that is, the time it took for the athlete to exhaust the total energy of the body, and the time was recorded to calculate the average time. Venous blood was collected at the 0^{th}, 30^{th} and 60^{th} min. 1 mL of venous blood was extracted using a vacuum sterile tube and then put into an anticoagulant tube for full mixing and stored at -20°C. After shooting for 30 minutes, the physical function changes of players were continued to observe and record.

3. Determination method of each index

a. Serum urea determination test

SK3003 semi-automatic biochemical analyzer (Shenzhen Sinothinker Technology Co., Ltd., China) was used for the determination. The kit used was the urea determination kit (Zhejiang Kaicheng Biotechnology Co., Ltd., China), and its principle is that urea generates NH_3 and CO_2 under urease hydrolysis and ammonia reacts with NAHD to generate glutamate and NAD + under the action of glutamate dehydrogenase.

b. Liver glycogen determination test (10)

I Serum: The blood was centrifugated for 10 minutes at the speed of 3000 rpm to collect the upper layer of serum.

II Plasma: The plasma was anticoagulated with Ethylene Diamine Tetraacetic Acid (EDTA), citrate or heparin and centrifugated for 30 minutes at the speed of 3000 rpm to collect the upper layer of serum.

III Cell supernatant: The cell supernatant was centrifugated for 10 min at the speed of 3000 rpm to remove particles and polymers.

IV Tissue homogenization: The tissue homogenization was mashed and centrifugated for 10 min at the speed of 3000 rpm to collect the upper layer of serum.

c. Blood lactic acid determination test

Beckman LX20 automatic biochemical analyzer (Beckman, USA) was used for determination. The kit used was lactate oxidase assay kit (Beijing Leadman Biochemical Technology Co., Ltd., China), and its principle is that lactate oxidase reacts with lactate to generate pyruvate and hydrogen peroxide, hydrogen peroxide reacts with 4-aminoantipyrine and p-chlorophenol to generate red quinoid dye.

Experimental results

Statistical methods were used to sort out and summarize the experimental data. Relevant calculations were carried out on the statistical analysis software statistic package for social science (SPSS). The general linear regression repeat measurement method was adopted to examine the differences in the effects of supplementing different anti-fatigue nutritional beverages on various metabolic indexes of the body.

0.05 was taken as defined value. When $P > 0.05$, there was no significant difference; when $P < 0.05$, there was a significant difference between groups; when $P < 0.01$, there was a highly significant difference between groups.

1. The comparison of the average exhaustion time between different groups of athletes is shown in Table 1.

The prolongation of exhaustion time means the improvement of exercise endurance under the same exercise intensity. The slowdown of body energy

Table 1. Effects of different anti-fatigue nutritional beverages on average exhaustion time

Group	Number of people/n	Average exhaustion time/min	P value
The control group	10	30.6	——
Sugar beverage group	10	49.8*	0.027
Taurine beverage group	10	53.7*	0.016
Tea beverage group	10	45.3*	0.047

* indicates $P < 0.05$ compared with the normal state.

consumption rate is one of the important forms to enhance the anti-fatigue ability. The results showed that the average exhaustion time of the experimental groups increased significantly. It showed that the application of these three kinds of anti-fatigue nutritional beverages could enhance sports endurance and improve athletes' anti-fatigue ability.

2. The comparison of serum urea content in each group is shown in Table 2.

Table 2 showed that the experimental group could significantly improve the basketball players' serum urea content after intense exercise, compared with the control group. Among them, the tea beverage group had the most positive effect on serum urea value of human, far more than the other two groups. It suggested that the application of tea beverages may be more effective in improving the body's serum urea levels and thus better resisting fatigue.

3. The comparison of liver glycogen content in each group is shown in Table 3.

It could be seen from Table 3 that sugar beverages and taurine beverages played a significant role in promoting the synthesis of liver glycogen. However, it could be seen from P>0.05 that the increase of liver glycogen content in tea drinks was not obvious. In this experiment, the P value of taurine beverage group was smaller than 0.01, which indicated that the application of taurine beverage in basketball players' physical function was reflected in the significant increase of liver glycogen content, thus delaying fatigue time.

4. The comparison of blood lactic acid content between different groups is shown in Table 4.

Table 4 showed that that the blood lactic acid value of all the anti-fatigue nutritional drinks in all the experimental groups decreased in different degrees

Table 2. Effects of different anti-fatigue nutritional beverages on serum urea content

Group	Number of people/n	Serum urea at 0th min /(Mmol/l)	Serum urea at 30th min/(Mmol/l)	Serum urea at 60th min/(Mmol/l)	P value
The control group	10	4.85±0.24	5.13±0.29	5.14±0.32	——
Sugar beverage group	10	5.27±0.54	5.86±0.60	6.50±0.65*	0.048
Taurine beverage group	10	4.96±0.51	5.46±0.63	6.14±0.69*	0.035
Tea beverage group	10	5.24±0.58	6.0±0.72	6.84±0.83*	0.012

* indicates P < 0.05 compared with the normal state.

Table 3. Effects of different anti-fatigue nutrition beverages on liver glycogen content

Group	Number of people/n	Liver glycogen at 0th min/g	Liver glycogen at 30th min /g	Liver glycogen at 60th min/g	P value
The control group	10	98.6±8.7	106.0±8.4	113.2±8.1	——
Sugar beverage group	10	100.2±8.3	108.3±9.2	117.8±10.6*	0.028
Taurine beverage group	10	97.4±7.9	107.6±11.3	120.5±13.9*	0.009
Tea beverage group	10	95.9±8.6	103.6±8.8	112.0±9.3	0.261

* indicates P < 0.05 compared with the normal state.

Table 4. Effects of different anti-fatigue nutritional beverages on blood lactic acid content

Group	Number of people/n	Blood lactic acid at 0th min/(Mmol/l)	Blood lactic acid at 30th min/(Mmol/l)	Blood lactic acid at 60th min/(Mmol/l)	P value
The control group	10	1.23±0.27	1.75±0.35	1.93±0.45	——
Sugar beverage group	10	1.14±0.13	1.12±0.15	1.09±0.19*	0.034
Taurine beverage group	10	1.03±0.26	1.02±0.30	0.97±0.37*	0.047
Tea beverage group	10	0.98±0.21	0.97±0.24	0.95±0.23*	0.045

compared with the normal value of the control group. Among them, the P value of sugar beverage was close to 0.01, and compared with other experimental groups, the reduction of blood lactic acid was more obvious. It suggested that the application of sugar beverage in anti-fatigue of basketball players was beneficial in slowing down the formation of lactic acid, which helped athletes maintain more sustained energy.

Discussion

Anti-fatigue nutritional beverage refers to a beverage that adds nutrient fortification ingredients on the basis of certain scientific research to supplement the special nutritional needs of some people (11). Proper consumption of nutritious beverages can help to improve the central inhibition after high-intensity exercise and achieve the ideal effect of anti-fatigue. At present, the development of anti-fatigue nutritional beverage in China still maintains the growth momentum of high sales, its application is becoming more and more diversified, and the overall industry development trend is optimistic. Nutritional beverages are gradually expanding their market share and are generally used in sports and auxiliary processes for sub-health people to improve their body functions (12). From the results of Table 1, it could be found that the exhaustion time of the experimental groups after drinking was significantly different from that of the pure water group ($P < 0.05$), indicating that the anti-fatigue nutritional beverage can effectively prolong the exhaustion time, thereby reducing the fatigue degree of the body.

Serum urea is a sensitive indicator to measure the fatigue degree, and the increase of serum urea value means that the body's exercise adaptability becomes worse (13). It could be seen from the results in Table 2 that the increase of serum urea in the tea beverage group was better than that in the control group, which proved that the components contained in tea beverage can stimulate serum urea, so as to improve the physical function.

Liver glycogen synthesis plays an important role in regulating the normal function of tissues in vivo. The more glycogen is generated, the longer the duration of exercise time that can be supported (14). As shown in Table 3, the liver glycogen content of the taurine beverage group was significantly different from that of the other three groups after the experiment ($P<0.05$), indicating that taurine beverage can effectively promote the formation of liver glycogen after exercise and proving its role in promoting fatigue recovery.

The blood lactic acid content is closely related to the acid-base balance *in vivo* . Basketball players engage in anaerobic exercise, leading to a lack of oxygen in the body, which increases blood lactic acid level. The direct result of increased lactate secretion is a decrease in the body's internal PH, which causes muscle soreness and limb weakness. As shown in Table 3, the liver glycogen content of the taurine beverage group was significantly different from that of the other three groups after the experiment ($P<0.05$), indicating that taurine beverage can effectively promote the formation of liver glycogen after exercise and proving its role in promoting fatigue recovery.

Conclusion

Starting from exploring the application of different anti-fatigue nutritional beverages, three representative anti-fatigue nutritional beverages were selected with basketball players as experimental objects. The average exhaustion time and the content of serum urea, hepatic glycogen and blood lactic acid were measured and calculated by reagents. Statistical method was used during the study. Finally, the final results were obtained by comparing the effects of three different beverages. The experiment shows that:

1) sugar drinks, taurine drinks and tea drinks can all prolong the exhaustion time of human body and improve the anti-fatigue ability of athletes;
2) anti-fatigue beverage can improve the content of urea in human serum, among which tea beverage has the most significant effect;
3) sugar drinks and taurine drinks are beneficial to the synthesis of glycogen in human liver, among which taurine drinks play the most significant role;
4) the anti-fatigue beverage can inhibit the production of blood lactate, among which sugar beverage has the most significant effect.

This experiment provides an effective attempt to study the combination of sports health and the practical application of various anti-fatigue nutritional beverages, contributes to the effective improvement of athletes' fatigue situation and the correct supplement of physical function, and provides a possibility for athletes to improve their performance to the greatest extent. It provides a scientific basis for further rational selection and application of sports beverages.

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