The study of the Spatholobus decoction on improving the maximal oxygen uptake of track and field athletes

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Abstract. Objective: It aims to observe the effect of Spatholobus decoction on the maximum oxygen uptake of athletes.This is of great significance to improve the endurance of athletes. Methods: Male sprint athletes in sports schools were randomly divided into a control group, and three experimental groups. The experiment period lasted for four weeks, and four groups ran 5,000 meters once a day, including warm-up and training. The second and fourth groups were given suberect Spatholobus decoction at a ratio of 2ml/kg according to the body weight of the participants. The control group and the third group received the same dose of water. Fasting blood biochemical indexes were determined at 8 a.m. the day before and the day after the experiment. The VO2 maximum load test was carried out on the same day. Half a year later, the same experiment was done by switching the control group and the fourth group, and the second group switched to the third group. Statistical data are collected and analyzed using SPSS analysis systemResults -(1) The correlation values of red blood cells in the second group had an obvious decreasing trend ($P<0.05$), but the results of the VO2max loading test had no change. (2) Leukocyte of the third group was significantly increased ($P<0.05$); the VO2 maximum load test showed a significant increase in respiratory quotient and vco2. $P<0.05$). (3) The blood biochemical indexes of the fourth group had no significant changes, but the VO2max ($P<0.01$), VCO2max ($P<0.05$) and the maximum detection time ($P<0.05$) were increased significantly. Conclusion: Spatholobus decoction can improve the oxygen delivery capacity of red blood cells and increase the VO2 max of endurance trainers under the condition of blood biochemical index balance.

1. Introduction

Spatholobus is a dried vine in the leguminous family. According to the “Compendium of Materia” Medica's Supplement and new insights into Herbal soup tablets, Spatholobus decoction "helps clear congestion and produce new blood."[1] Current research shows that the main components of Spatholobus are: vanillic acid and stem, tannin, lyphin, catechin, and Syrian acid. Long-term endurance training will cause changes in the body, especially in the blood[2]. Xia Luo et al. suggested that the mechanism by which Spatholobus acts on red blood cells may be related to the increase of T lymphocytes that stimulate the secretion of EPO or EPO activity[3]. They believe that Spatholobus decoction helps to repair lost red blood cells, death or destruction, and maintain the relative stability of red blood cells, thereby contributing to blood enrichment, by promoting the division, maturation and release of erythropoietin[4][5]. The main purpose of this study was to explore whether Spatholobus decoction could help the maximal oxygen uptake of professional athletes.

2. Objects and methods

2.1 Object

24 healthy male students from a sports school majoring in Athletics were divided into the control group (neither training nor drinking suberect Spatholobus decoction), the second group (only drinking Spatholobus decoction without training), the third group (only training without drinking Spatholobus decoction) and the fourth group (training and drinking suberect Spatholobus decoction). There are six students in each group. Half a year later, the control group switched with the fourth group, and the second group switched with the third group for the same experiment.

2.2 Methodology

Apparatus: Weighing-machine: (Korean N-40

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InBody220); Automatic biochemical analyzer: (Roche cobas c 501); Cycle ergometer: (VelotronTM Racemate, inc); VO2max analyzing system: (Cosmed K4b2 Italy).

Spatholobus decoction is prepared by Traditional Chinese Medicine researchers at Tianjin Medical University. Spatholobus decoction is made by Chengyitang brand, produced in Hunan Province, China, and takes 90 minutes to be produced.

The training lasts for four weeks, with one day off on Sundays each week. The daily training plan is as follows: 1. 20-minute warm-up with a 400-meter run by 6 times with 3 groups, with a 5-minute rest between groups; 2. Take a 10-minute break; 3.5000m running time. If the time was 20 seconds longer than the first record, the experimenter would add an 800-meter run.

The test methods of experimental data are as follows: 1. The maximum oxygen uptake test; 2. During the test, the indoor temperature is controlled at about 23℃ and the humidity is controlled at 50%. The experimenters performed mass movements on a VO2 Max machine. This process continues until the experimenter is exhausted.

Blood collection and analysis were conducted by a blood collection centre of a university hospital. Fasting blood samples were collected from all subjects at 8 a.m. on the days before and after the experiment. Blood biochemical analysis was performed by a biochemical analyzer (Roche cobas c 501). SPSS was used for paired sample T-test.

3. Results

3.1 Effects on red blood cells

The values of RBC, HGB, HCT, MCV, and MCHC were compared with those before the experiment as shown in the table 1. There was no significant difference between the control and control groups, although some indexes increased slightly. In the second group, RBC ↓ (5.506±0.222→5.332±0.192), HGB ↓ (163.2±10.189→158.4±10.453), HCT ↓ (48.72±3.217→46.88±2.784) were discrete, and the difference was statistically significant (P< 0.05). In the comparison, it was found that Spatholobus decoction can promote the proliferation of red blood cell precursor cells 7, 8, and 9, which contributes to the balance of blood cells. After long-term use of Spatholobus decoction, there will be reduced erythrocyte circulation in healthy people in the resting state, and it can be inferred that the existing erythrocyte is enough to meet the metabolic needs of the body in the resting state due to the improvement of hemoglobin oxygen-carrying capacity. The average values of each index in the third and fourth groups decreased slightly, but there was no significant change. It was inferred that although the oxygen-carrying capacity of erythrocytes in the training group was improved, the non-significant decrease in erythrocytes was due to the body's resting state recovery.

Table 1 List of Effects of SSD Decoction on RBC-Related indicators

Item name		Control Group	Group 2	Group 3	Group 4
RBC (×1012/L)	before	5.072±0.339	5.506±0.222	5.098±5.81	5.2983±5.12
	After	5.152±0.296	5.332±0.192	5.08±5.45	5.255±5.72
	T-test	0.405	0.0365*	0.7575	0.4504
HGB (g/L)	before	157.4±6.308	163.2±10.189	150.6±6.841	158.5±7.449
	After	159±8.86	1158.4±10.453	148.6±9.208	157.17±.261
	T-test	0.601	0.0256*	0.3327	0.4142
HCT (%)	before	46.74±2.296	48.72±3.217	45.38±2.008	48.2±1.823
	After	47.56±2.152	46.88±2.784	45.14±2.614	47.633±2.633
	T-test	0.3563	0.0455*	0.5596	0.3387
MCV (fL)	before	92.26±2.496	89.94±2.794	89.3±5.294	91.05±2.480
	After	92.38±2.980	89.82±2.843	89.24±5.318	90.683±2.322
	T-test	0.7695	0.6585	0.8889	0.2367
MCH (pg)	before	31.1±1.264	30.38±1.100	29.7±2.013	29.933±0.524
	After	30.68±1.245	30.1±0.883	29.46±1.825	30.017±0.667
	T-test	0.1433	0.2721	0.1778	0.4341
MCHC (g/L)	before	336.4±6.426	337.8±2.863	331.8±5.357	328.67±5.046
	After	334.2±6.906	335±6	329.2±3.033	330±3.898
	T-test	0.3299	0.3351	0.2857	0.1747

3.2 Effect on white cell

After the experiment, the influence of the third group (6.176 + / - 0.759 x 109 / L - 7.336 + / - 1.465 x 109 / L) of white blood cell count increased, and the difference was statistically significant (P < 0.05) as shown in the table 2. There was no significant difference in the other groups, but the fourth group had a slight increase in white blood cells. In exercise training, Spatholobus decoction can relieve inflammation caused by microenvironment injury in the body to a certain extent.

Table 2 List of Effects of SSD Decoction on White Blood Cell

Item name		Control Group	Group 2	Group 3	Group 4
WBC (×109/L)	before	6.132±1.362	7.086±0.676	6.176±0.759×109/L	5.615±0.917
	After	6.428±1.821	7.32±1.192	7.336±1.465×109/L	6.48±2.344
	T-test	0.3706	0.567	0.0295*	0.4437

3.3 influence on platelet

Experiment index (PLT, PDW, MPV) comparison shows that two groups of average PLT numbers have risen, and a second group of average PLT numbers declined as shown in the table 3. However, there was no significant difference among all groups, indicating that the experiment had little effect on the coagulation system.

Table 3 List of Effects of SSD Decoction on Blood Platelet-Related Indicators

Item name		Control Group	Group 2	Group 3	Group 4
PLT (×109/L)	before	201.2±33.663	262±36.517	239.2±19.842	226.83±45.762
	After	201.8±31.38	249.8±34.853	243.2±4.604	233.17±48.795
	T-test	0.878	0.3035	0.7129	0.533
PDW (%)	before	11.18±0.705	11.44±2.640	12.04±1.744	9.433±0.564
	After	11.32±0.925	11.12±2.253	11.24±1.485	9.55±0.723
	T-test	0.5155	0.2075	0.2466	0.2387
MPV (fL)	before	10.08±0.164	9.9±1.166	10.12±0.645	9.05±0.516
	After	10.02±0.342	9.94±1.043	9.94±0.709	9.083±0.435
	T-test	0.6745	0.587	0.5203	0.6383

3.4 Maximum testing time and heart rate

The maximum testing time of subjects adhering to the VO2 maximum load test and maximum heart rate before and after the test was found to have increased the maximum test time in each group, while a particularly significant increase was observed in the fourth group from 638.83±90.015 to 714±73.832. The T-test result was ($P<0.01$) as shown in the table 4. The HRmax of the control group increased from 188±2.39 to 199±5.04, showing an upward trend. The experimental results of the other groups were: second group ↑ (195.8±6.49→194±3.67), ↓ (192.4±8.70→196.4±8.26) in the third group, and ↑ (188.17±7.80→192.17±9.94) in the fourth group, showing no statistical significance.

Table 4 List of Effects of SSD on Indicators of Load Test

Item name		Control Group	Group 2	Group 3	Group 4
Test time max（〃）	before	645.2±153.55	664.4±101.4	645.2±24.813	638.83±90.015
	After	660.6±133.34	700.6±91.868	652.2±22.676	714±73.832
	T-test	0.5652	0.2562	0.2784	0.0076**
HRmax (bpm)	before	188±2.39	195.8±6.49	192.4±8.70	188.17±7.80
	After	199±5.04	194±3.67	196.4±8.26	192.17±9.94
	T-test	0.0079＊＊	0.6503	0.2663	0.0954

3.5 Influence on the respiratory system

The values of VO2max, VCO2max and RQ of each group after the experiment were compared with those before the experiment. For the control group, although HRmax showed a clear upward trend in Table 4, the mean value of VO2max actually decreased slightly rather than increased, indicating that there was no necessary association between an improvement in maximum heart rate and an improvement in VO2max.

VO2max ↑ (3341.2±805.09 → 3444.3±612.87), VCO2max↑3996.8±1001.2 → 4000.7±545.79) and RQ↑ (1.2378±0.031→1.3047±0.073) in the second group showed no significant differences.

The VO2max ↑ (3221.6±417.82 → 3330.7±409.6) of the third group also had no significant difference. However, VCO2max ↑ (3550±371.76 → 3731.6±351.94) increased significantly after the experiment, indicating that the ability of organisms to make full use of oxygen energy was improved. The positive effect of endurance training was demonstrated by an increase in maximum energy for improving bioavailability. At the same time, a significant difference was found in RQ ↑ (1.2422±0.092 → 1.2815±0.087) ($P<0.05$)) because the maximum

energy in the oxygen used by the organism rises at a higher rate than VO2max.

For the fourth group, VO2max↑ (3244.1±489.32→ 4058.2±421.65) increased significantly (P< 0.01). The effect was significantly improved after treatment with Jispatholobi decoction and endurance training aimed at improving the muscle's ability to use oxygen. In addition, VCO2max↑ (1.2041±0.098→ 1.2671±0.085) increased as significantly as the training group (P< 0.05). As VO2max and VCO2max both increased significantly, RQ did not change significantly in the experiment.

3.6 Changes in body weight of the participants

There was little change in body weight in all groups at the end of the experiment. Both training groups showed slight weight loss. Therefore, the change in body weight was not statistically significant, indicating that this study had little effect on body weight.

4. Discussion

Half a year later, the control group switched with the fourth group, while the second group switched with the third group for the same experiment, because there were fewer samples in a single experiment[6]. When the number of people in a single group reached 12, the experimental data from the two experiments were analyzed together.

Red blood cells are the most abundant in the blood, serving as the main carriers of oxygen and carbon dioxide in vertebrate blood[7]. Hemoglobin is a protein in higher animals responsible for carrying oxygen. Hemoglobin consists of four chains, two chains, and two chains, each with a circular heme-containing iron atom[8]. Oxygen binds to iron atoms and is transported through the blood by hemoglobin[9]. Hemoglobin is characterized by its easy binding to oxygen in a high-oxygen environment and its easy separation in a low-oxygen environment, which allows red blood cells to transport oxygen[10]. It is speculated that the significant downward trend of RBC, HGB and HCT after the second experiment ascribes to the decrease of red blood cells in the resting blood circulation. Since there was no significant difference in MCH, MCHC, and body weight, the reduction in red blood cells indicated no improvement in the oxygen-carrying capacity of red blood cells under the assumed basic metabolic requirements of the two groups. Hemoglobin is a conjugated hemoglobin composed of heme and globin, whose main function is to transport oxygen[11]. After an increase in the oxygen-carrying capacity of the red blood cells, the red blood cell count in the resting body was inevitably reduced, and the reduction in the red blood cell, HGB and HCT was predictable because the subjects were track and field athletes.

Although there was no significant difference in MCH and MCHC in the fourth group after the end of the experiment, both showed an increasing trend. In addition, VO2max and VCO2max increased significantly, respectively. A large number of studies 7, 8, and 9 showed that Spatholobus decoction can effectively stimulate the proliferation of primitive erythroid progenitor cells (BFU-E) and late erythroid progenitor cells (CFU-E) and reconstruct the bone marrow microenvironment. From these studies, conclusions can be drawn about the role of Spatholobus on the blood transport system. In human movement training, the balance of human movement will be broken. In the process of re-establishing balance, Spatholobus' role is to increase the hemoglobin in red blood cells, which in turn increases the oxygen and carbon dioxide-carrying capacity of red blood cells[12]. This helps to establish balance in a more efficient way, which contributes to new achievements in endurance training. White blood cells are immune cells. The white blood cell count in the blood is relatively stable, except that it increases significantly when there is inflammation. The results showed that it increased from 7.236±1.565×109/L to 6.076±0.859×109/L, which significantly increased by 1.16×109/L. This result is similar to the results of most other studies, so a detailed explanation won't be given here. Damage to the microbial microenvironment is a cause of inflammation, but there was no significant difference in white blood cells in the fourth group, despite the observed increase. This is mainly because Spatholobus can effectively improve white blood cell count. A large number of studies 9, 10, 11, and 12 have shown that Spatholobus can inhibit chemotherapy-induced leukopenia.

After the experiment, the mean value of PLT after training increased in both groups, which was consistent with the results 14 and 15 of other studies, namely, exercise training may lead to an increase in platelets and platelet content. There was no significant difference in PLT in this study. The statistical data in this study are insufficient to support the effect of subspatholobi decoction on improving certain indicators of the blood coagulation system. Based on previous research, caulis spatholobi is expected to help overcome adverse factors. The object of this study is human, and there are many uncontrollable factors in human daily life. Therefore, it is not recommended to compare the statistics from this study with those from rat experiments.

Compared with the other three groups, the maximum test time in the VO2 maximum load test in the fourth group was significantly increased (P< 0.01), indicating that the combined training of Spatholobus decoction improved the endurance of experimental personnel. Long-term exercise training may result in the production of a large number of exercise-derived free radicals. This will lead to a decline in exercise ability, which can lead to exercise fatigue. In other studies, it has been found that Spatholobus has antiviral, antioxidant, and antitumor effects, and has the function of inhibiting protease and controlling arrhythmia[13]. The analysis showed that Spatholobus decoction improved the endurance of participants by effectively removing the free radicals produced and improving blood circulation.

The heart rate results of the control group showed that the heart rate was significantly higher after the experiment than before. The control group did not receive exercise training and Spatholobus decoction, and the body maintained no fatigue state. In addition, the experimenters were able to put more effort into the first test because they knew exactly when and what the first test would be.

Therefore, the body's immediate response to the experiment was an increase in heart rate. However, no increase in heart rate was observed due to improvements in the oxygen-carrying capacity of hemoglobin in the other groups. Reports of an explanation for the increase in heart rate have not been found and cannot be adequately demonstrated by existing studies, so this aspect will continue to be analyzed.

After the experiment, the VCO2max of the third group and the fourth group showed an obvious increasing trend. VCO2max increased moderately in the third group and significantly in the fourth group. These changes suggest that training for fast running, which repeatedly stimulates the muscles, trains the muscles' oxygen demand but does not significantly improve the oxygen-carrying capacity of red blood cells. However, VO2max increased significantly in the fourth group, indicating the contribution of Spatholobus decoction.

5. Conclusion

(1) Spatholobus decoction can improve the oxygen-carrying capacity of red blood cells, thus increasing VO2 max.

(2) A major function of endurance training is to improve the body's ability to make full use of oxygen per unit of time.

(3) Combining exercise training with suberect Spatholobus can more effectively rebuild the dynamic balance of the body, which is of great significance for improving the effect of endurance training.

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