



ANTI-EXERCISE FATIGUE EFFECT OF BAZHEN DECOCTION ADDED WITH CINNAMON AND FRUCTUS PSORALEAE

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ABSTRACT

The relief effect of Bazhen decoction added with cinnamon and fructus psoraleae on exercise induced fatigue was analyzed by establishing rat exercise-induced fatigue models. Ninety Sprague dawley (SD) male rats were selected and randomly divided into three groups, i.e., control group, model group and test group, according to experimental requirements. Rats in the control group were not trained, but chronic exercise induced fatigue models were set up in the other two groups. Rats in the control group were fed normally, under the condition of no exercise training; rats in the model group were gavaged with normal saline as placebo once within half an hour after daily training; rats in the test group were gavaged with a compound traditional Chinese medicine, i.e., Bazhen decoction added with cinnamon and fructus psoraleae once within half an hour after daily training. Results suggested that, Bazhen decoction added with cinnamon and fructus psoraleae could increase the content of hemoglobin in blood, inhibit the catabolism of heme, keep the metabolism of hemoglobin at a relatively low level, increase the synthesis of hemoglobin, enhance the immune function of red blood cells, improve hematopoietic function, and effectively relieve exercise-induced anemia. Besides, Bazhen decoction added with cinnamon and fructus psoraleae could relieve or eliminate exercise-induced fatigue by promoting the reduction of creatine kinase (CK) content, lowering the permeability of cytomembrane, and inhibiting the release of CK in cells.

1. Introduction

With the constant improvement of modern competitive level, competition has become increasingly intense and the intensity of training of sportsmen is increasing; under such an environment, such kind of overload training and competition will result in higher risks of exercise-induced fatigue (Sargent et al., 2014; Halson, 2014; Zhai, 2013). Fatigue will accumulate if body cannot be effectively relieved. If exercise-induced fatigue cannot recover timely and the functions and immunity of body cannot be improved timely, the risks of diseases will be higher, which can directly

affect the fulfillment of skilled movement and competition performance of sportsmen and even increase the risks of exercise injuries (Joshi et al., 2013). Thus searching for effective methods that can delay or eliminate exercise induced central fatigue is the key point that is urgent for study. Bazhen decoction added with cinnamon and fructus psoraleae is an improvement on Bazhen decoction, which is a convenient and simple way to resist exercise-induced fatigue.

The mechanism for the generation of exercise-induced fatigue is complex. When exercise induced fatigue generates, the

functional levels of tissues and organs in human body will decline; therefore, fatigue can be evaluated based on the changes of functional level of organs and tissues in human body (Radiloff et al., 2014; Benson and Mushtaq, 2015; Tomlinson et al., 2014). In the field of competitive sports, how to strengthen and enhance the immunity of sportsmen so that they can keep a healthy constitution and a good competitive state is a key problem that needs to be solved (Goodall et al., 2014; Meneses-Echávez et al., 2014; Durcan et al., 2014). Traditional Chinese medicine as the traditional medicine of Chinese nation has its special advantages in promoting the recovery of exercise-induced fatigue and improving exercise capacity for its high safety without any side effects (Wang et al., 2014). Erqun Song et al. (Erqun et al., 2014) found that, Bazhen decoction had functions of notifying qi, nourishing blood, and supplementing kidney; cinnamon and fructus psoraleae were highly effective in resisting oxidation and regulating immune; the addition of cinnamon and fructus psoraleae in Bazhen decoction could improve the efficacy of Bazhen decoction.

Bazhen decoction added with cinnamon and fructus psoraleae is made from ginseng, white paeony root, Angelica sinensis, Rehmannia Glutinosa, Ligusticum wallichii, white atractylodes rhizome, Poria cocos, liquorice, Eucommia ulmoides, cinnamon, radix achyranthis bidentatae, Radix Dipsaci Asperoidis, Chinese yam and fructus psoraleae, which has functions of nourishing kidney, enriching qi, strengthening muscles and bones, tonifying liver, replenishing yin and tonifying yang. Through an experiment on rats with exercise-induced fatigue, this study discussed the relief effect of Bazhen decoction added with cinnamon and fructus psoraleae on exercise-induced fatigue.

2. Experimental subjects and methods

2.1. Experimental subjects

Ninety healthy male Sprague-Dawley (SD) rats, weighed 180 ~ 220 g, were selected. They

were fed by national standard dried feed for rodent and trained indoor. They were raised in different cages, in a ventilated room and under natural lighting. The test lasted for 6 weeks. During experiment, the exercise of the rats was observed timely; besides, the rats were motivated to run continuously by stimulation using electricity or instruments. The temperature and humidity of the laboratory, ingestion, water drinking, defecation, fur and exercise capacity were checked every day. Besides, weights of the rats were weighed and recorded before exercise at the first day of every week.

2.2. Experimental method

2.2.1. The preparation of Bazhen decoction added with cinnamon and fructus psoraleae

Ginseng, white paeony root, Angelica sinensis, Rehmannia Glutinosa, Ligusticum wallichii, white atractylodes rhizome, Poria cocos, liquorice, Eucommia ulmoides (9 g each), cinnamon (3 g), radix achyranthis bidentatae, Radix Dipsaci Asperoidis, Chinese yam (6 g each) and fructus psoraleae (9 g) were taken and prepared by means of immersion and decoction to control and reduce the toxic and side effect of drugs. Finally it was condensed into a solution with a concentration of 100%. Then the solution was stored at 4 °C.

2.2.2 Experimental grouping

The room temperature was controlled at around 23 °C and the indoor humidity was kept at about 55%. The lighting was free. The laboratory was cleaned and disinfected every two days. The rats were weighed once every week. After one week of adaptive raising, rats in the control group were fed in natural way every day, rats in the model group were gavaged with 0.1 ml/10 g of normal saline every day, and rats in the test group were gavaged with 800 mg/kg Bazhen decoction added with cinnamon and fructus psoraleae two hours before exercise every day.

Except the control group, rats in the other two groups were required for swimming training once each day. The swimming box

used in the experiment had a size of 80 cm × 46 cm × 40 cm. The water depth was kept equal to or higher than 30 cm, and the water temperature was kept at 28 °C. Rats did exercise from am 7:30 to am 11:30 at the first six days of every week and rested on Sunday. The physical condition before and after exercise was recorded. The rats swam for 30 min at the first week, 10 min more afterwards till the fourth week. At the fourth week, the rats swam for 60 min every day; after the fourth week, the duration of swimming was kept at 60 min, for one week.

At the last day of experiment, one hour after the administration of Bazhen decoction added with cinnamon and fructus psoraleae of the test group, all rats did exhaustive swimming group by group. Rats were determined as exhaustive if they were immersed into water for more than 8 s and could not do righting reflex on plane. The duration of exhaustive swimming was recorded.

2.3. Material analysis

2.3.1 Index testing method

Chloral hydrate solution with a concentration of 10% was used to narcotize rats in group through abdominal cavity, in a dose of 0.3 ml/10 g. Then the abdominal skin and muscles were cut apart to expose abdominal aorta; 5 ml of artery blood was collected through abdominal aorta puncture. After one hour of standing at room temperature, it was centrifuged at 3000 r/min for 10 min. The supernate was isolated, transferred to a 2 ml freezing tube, and stored at - 80 °C. After the

collection of blood, liver and muscle tissues were resected immediately, washed by normal saline, dried using filter paper, and stored at - 80 °C. Hemoglobin (Hb) and the content of creatine kinase (CK) in plasma and relevant liquid samples were detected using enzyme-linked immunosorbent assay (ELISA) kit and biotin double antibody sandwich technology.

2.4. Statistical processing

Data were expressed as mean ± standard error (SE). SPSS for Windows 16.0 was used for statistical analysis.

3. Results and discussions

3.1. The observation of general condition and weight change of rats in groups

Rats in the control group demonstrated normal food taking and water drinking states, weight increase and activity as well as smooth fur; rats in the model group and the test group were observed with good mental state and lively and active action, and symptoms such as decreased amount of food taking or water drinking, weight loss, squintm, fatigue and withered and dried fur were not observed. Compared to the control group, the model group and the test group had no abnormal situation. It could be seen from Table 1 that, all groups showed an increasing tendency of weight, suggesting progressive increasing load training did not induce excessive fatigue and rats showed no adverse reactions to the medicine.

Table 1. The weight change of rats in groups

	1st week	2nd week	3rd week	4th week	5th week
Control group	216.33±11.32	299.47±21.98	321.87±36.11	345.14±26.32	369.21±18.49
Model group	214.14±16.11	271.56±28.54	301.45±30.74	314.95±33.32	331.78±30.32
Test group	219.45±14.75	267.14±13.63	294.87±18.36	313.54±20.96	338.23±15.23

3.2. Effects of Bazhen decoction added with cinnamon and fructus psoraleae on exhaustive swimming time of rats

Table 2 demonstrates that, the duration of exhaustive swimming of rats in the test group

was longer than that of the model group, but there was no statistically significant difference ($p > 0.05$), suggesting Bazhen decoction added with cinnamon and fructus psoraleae could extend exercise time and improve endurance.

Table 2. The duration of exhaustive swimming of rats in groups

	Duration of exhaustive swimming (min)
Model group	168.23±28.65
Test group	211.45±30.21

3.3. Test results of Hb

Hb can reflect the oxygen carrying capacity of blood during exercise. Excessive training can damage red blood cells, reduce the content of Hb and even induce exercise-induced anemia in severe cases. For middle and long-distance runners, the content of Hb is required to be at a normal level or higher than middle level. The enhancement of oxygen transport and carrying capacity of blood is helpful to the improvement of sports performance and exercise capacity of sportsmen engaging in middle and long-distance running events (Ronghui, 2015; Matos et al., 2014). Table 3 shows that, Hb of the model group at the 5th and 6th week was lower than that at the 1st week and 3rd week,

and the difference was highly statistically significant ($p < 0.01$); at the 5th week, Hb of the test group showed a decreasing tendency, and the difference with the control group was highly statistically significant ($p < 0.01$); at the 6th week, Hb of the test group was lower than that of the control group ($p < 0.05$), but higher than that of the model group, and the difference was highly statistically significant ($p < 0.01$). It suggested that, Bazhen decoction added with cinnamon and fructus psoraleae promoted the content of Hb in blood of rats, inhibited the catabolism of heme, enhanced the immune function of red blood cells, improved hematopoietic function, and effectively relieved exercise-induced anemia.

Table 3. The change of Hb of rats in groups (g/L)

	1st week	3rd week	5th week	6th week
Control group	145.45±6.39	146.14±10.36	147.25±6.47	140.21±9.14
Model group	148.14±6.21	142.58±14.14	115.98±14.74	118.21±3.56
Test group	150.21±4.47	142.45±16.39	131.47±12.41	133.87±10.96

3.4. Test results of CK

CK involving in the control of glycolysis as well as the contraction and energy supply of muscle is one of the key enzymes in ATP-CP energy supply system metabolism. Distributed in skeletal muscle, brain tissue and heart of animals, CK can satisfy the physiological need of organs and tissues. Stimulation, no matter high strength or low strength, can result in the increase of serum CK; hence serum CK is considered as one of the most sensitive indexes for training load (Hody et al., 2013; Leite et al., 2013). Table 4 demonstrates that, the value of CK of the model group at the 5th week was higher than that at the 3rd week ($p < 0.05$) and extremely higher than the control group ($p < 0.01$), suggesting body had been fatigued; at the

5th week, the value of CK in the test group was no remarkably different with that in the control group, but much lower than that in the model group ($p < 0.01$); the CK values of the control group, model group and test group at the 6th week were much lower than those at the 1st, 3rd and 5th week, and the differences were statistically significant ($p < 0.05$); at the 6th week, the CK value of the test group was extremely lower than that of the control group ($p < 0.01$) and much lower than that of the model group ($p < 0.05$). It indicated that, Bazhen decoction added with cinnamon and fructus psoraleae could reduce the content of CK and the permeability of cytomembrane, and restrain the release of CK in cells, thereby relieving exercise-induced fatigue.

Table 4. The change of CK in groups (μ /l)

	1st week	3rd week	5th week	6th week
Control group	557.23 \pm 125.14	506.32 \pm 115.47	462.35 \pm 50.68	256.47 \pm 23.84
Model group	658.89 \pm 167.46	584.22 \pm 122.63	699.98 \pm 59.96	260.74 \pm 9.65
Test group	705.32 \pm 142.51	631.89 \pm 169.58	480.63 \pm 66.41	233.49 \pm 18.63

4. Conclusions

Research results demonstrated that, Bazhen decoction added with cinnamon and fructus psoraleae could increase the content of Hb in blood, restrain the catabolism of heme, enhance immune functions of red blood cells, improve hematopoietic function, and effectively relieve exercise-induced anemia. Besides, the decoction could reduce the content of CK of rats with exercise-induced fatigue, reduce the permeability of cytomembrane, and inhibit the release of CK in cells. To sum up, the supplement of Bazhen decoction added with cinnamon and fructus psoraleae can improve the fatigue resistance of the body.

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