

Research Article

Effect of Jujube Date Polysaccharide in Resisting Sports Fatigue

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Abstract: This study aims to explore effect of jujube date polysaccharide in relieving fatigue caused by sports taking rats as research object, in order to provide experimental basis for development of health care products made up of jujube date polysaccharide. Anti-fatigue effect of jujube date polysaccharide was observed through comparing duration of loaded swimming to exhaust, weight growth and content of blood lactic acid, blood urea nitrogen, blood glucose, muscle glycogen and hepatic glycogen of rats in sedentary group, control group and experimental group. Duration of loaded swimming to exhaust of weight-bearing rats in experimental group was obviously longer than control group; once the experiment ended up, weight of rats in experimental group was detected to be significantly higher than control group; after swimming, content of blood lactic acid and blood urea nitrogen of rats in experimental group was found to be decreased; rats taking medium and high dose jujube date polysaccharide had higher content of muscle glycogen and hepatic glycogen compared to control group. Thus the experiment proves that, jujube date polysaccharide can obviously strengthen the adaptive ability of human body to sports load, showing up its anti-fatigue effect.

Keywords: Anti-fatigue effect, jujube date polysaccharide

INTRODUCTION

As people's living pace speeds up, various invisible pressure increases sharply, urging us to live with sub-health and even unhealthy state. After work, people like to relax by sports. But for those who usually stay indoors, sudden exercises will make them uncomfortable and fatigue. Thus a problem comes out, that is, how to relieve fatigue caused by sports and how to avoid damage of body during sports. Through research, we find that, supplementing antioxidant substance and nutrition supplements that can improve immune functions is effective in relieving fatigue caused by sports.

Recently, researchers have found polysaccharides from plant can also strengthen immune ability, besides resisting inflammation, bacteria, virus, parasite, infection, peptic ulcer and coagulation, reducing blood fat and glucose and eliminating oxygen radical *in vivo* and *in vitro* (Lihong *et al.*, 2011).

Jujube, a mature fruit of *Zizyphus jujuba* Mill belonging to Rhamnaceae, have been planted in China for a long history. Planting area and output of jujube in China ranks the first worldwide (Xiangqian *et al.*, 2011; Yaolei *et al.*, 2013), which endows China a special advantage in developing jujube products.

Polysaccharide is an important bioactivator contained in jujube. With the emergence of new separation and detection means and development of life science, physiological activity and biological functions of jujube date polysaccharide gradually draws people's

attention. Jujube date polysaccharide is found to have wide biological functions. Previous researches have suggested that, jujube date polysaccharide can improve catalase activity in blood and liver of rats (Qing, 2011) and lower content of malonaldehyde in blood, liver and brain tissue of rats, which indicates its antioxidation; moreover, it is found to be effective in inhibiting serum total cholesterol, triglyceride and arteriosclerosis index and improving high density lipoprotein cholesterol level for high fat mediated rats (Rongfei and Xiaoyu, 2010); and it also can strengthen phagocytic function of macrophage, promote proliferation of lymphocyte, thereby enhancing immunocompetence (Ben, 2008; Defeng *et al.*, 2012; Lu and Yoshida, 2003).

Besides, jujube date polysaccharide is thought to be an active substance which performs well in improving immune function in the aspect of sports. This study detected duration of loaded swimming to exhaust, weight growth and content of blood lactic acid, blood urea nitrogen, blood glucose, muscle glycogen and hepatic glycogen of rats supplemented with a certain dose of jujube date polysaccharide and compared data between groups, in order to provide theoretical and experimental basis for development and application of sports health food made of jujube date polysaccharide.

MATERIALS AND METHODS

Experimental materials, reagents and instruments: Polysaccharide solution containing 4 mg jujube date

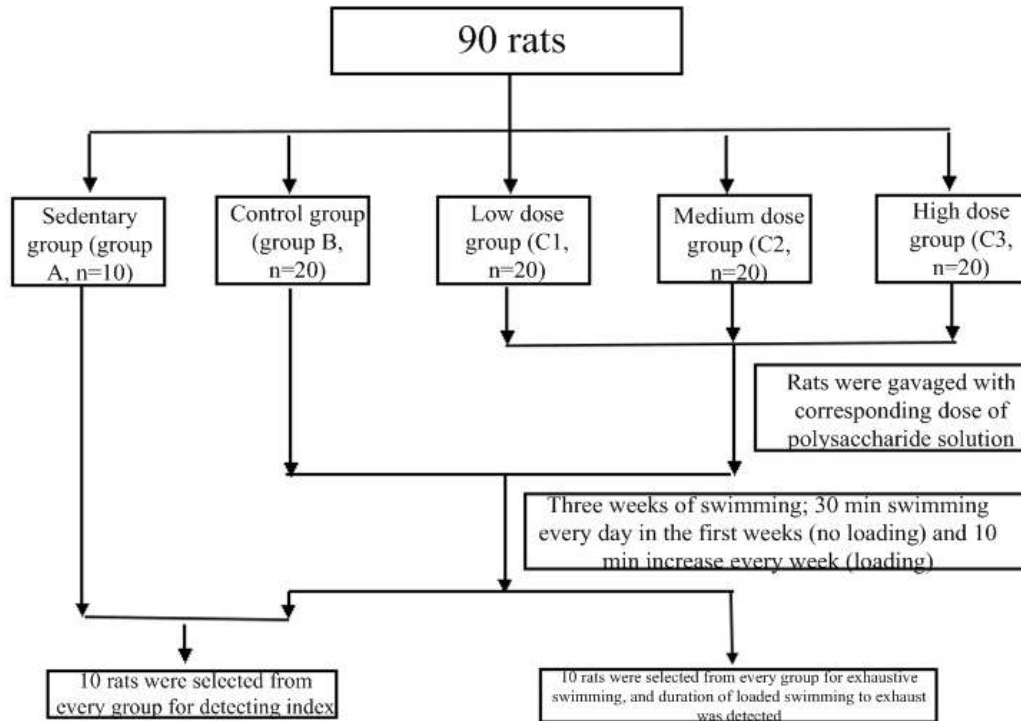


Fig. 1: Sports model of rats

polysaccharide and 1 mL distilled water is used in the experiment. Three groups were set up based on dose, i.e., low dose group (100 mg/kg/day), medium dose group (200 mg/kg/day) and high dose group (400 mg/kg/day). Then they were preserved at 5°C. Ninety healthy Institute for Cancer Research (ICR) male rats weighted from 20±2 g were selected and kept in cages separately and they were permitted to take food and water freely (Qingchun *et al.*, 2006). Main instruments used in the experiment include blood sugar check meter, wet and dry hygrometer, electronic balance, vacuum drying oven and blood lactate analyzer.

Experimental method: Rats were raised in the environment with 22~27°C and 50~60% of relative humidity for one week and the light varied with natural light (Bibo *et al.*, 2012). In next 3 days, the experiment was performed after 10 min of adaptive swimming. Rats were divided into 5 groups, sedentary group (n = 10, group A), control group (n = 20, group B), low dose group (n = 20, group C1), medium dose group (n = 20, group C2) and high dose group (n = 20, group C3). Two hours before exercises, rats in group C were administrated with corresponding dose of polysaccharide solution, while rats in group B were administrated with normal saline (50 mg/kg/day). Except group A, rats in the other groups were given swimming training. In Fig. 1, rats swam in special glass jar for 3 weeks, 2 h after gavage. In the first week, swimming was continued for 30 min (no loading) and one week later, 10 min was increased progressively every weeks (rats were loaded with galvanized wire

weighted 5% of their own weight on tail). The water in glass jar was 28~30°C and in depth of 40 cm.

Data measurement: Rats were determined to be exhausted if they swim disorderly, immerse into water for more than 10 sec and cannot complete righting reflex on plane (Yan and Yanming, 2009).

After load swimming, content of blood lactic acid, blood urea nitrogen, blood glucose, muscle glycogen and hepatic glycogen of rats were detected (Songhuan *et al.*, 2009). Content of blood lactic acid was measured by blood lactic acid analyzer and blood urea nitrogen was detected by enzyme coupling rate method. In the condition of heating and strong acid, blood urea nitrogen and diacetyl condensing into red diazine compound and content of urea nitrogen could be figured out based on depth of color (Hongtao, 2007). Content of blood sugar was measured by blood sugar check meter. Content of muscle glycogen and hepatic glycogen were detected by phenol-sulfuric acid method and its reaction principle is that, concentrated sulfuric acid can hydrolyze glycogen into furfural derivative which can react with phenol into red compound which has the maximum absorption peak at 490 nm; quantity can be confirmed by comparing absorption value of standard glucose solution processed in the same way.

Statistical method: Data Processing Station (DPS) was used for processing experimental data. Comparison between groups was tested by independent Student t test. Results were expressed as mean±standard

Table 1: Effect of jujube data polysaccharide on exhaustive time delay rate of rats

Group (n = 10)	Dose (mg/kg/day)	Time delay rate* (%)
B	-	-
C1	100	2.87
C2	200	16.58
C3	400	15.23

*: Exhaustive time delay rate = (exhaustive time of that group-exhaustive time of control group) /exhaustive time of that group

Table 2: Effect of jujube data polysaccharide on blood lactic acid and blood urea nitrogen of rats (mean±standard deviation)

Group (n = 10)	Dose (mg/kg/day)	Blood lactate (mmol/L)	Blood urea nitrogen (mmol/L)
A	-	4.21±0.65	5.27±0.49
B	-	5.43±0.99 ^a	7.99±1.32 ^a
C1	100	5.12±1.00	7.75±0.86 ^b
C2	200	5.31±0.79	6.75±0.88 ^b
C3	400	4.23±0.85 ^b	6.21±0.78 ^{bb}

a: p<0.05, compared to sedentary group; b: p<0.05, compared to control group; bb: p<0.01, compared to control group

Table 3: Effect of jujube data polysaccharide on content of blood sugar muscle glycogen and hepatic glycogen of rats (mean±standard deviation)

Group (n = 10)	Dose (mg/kg/day)	Blood glucose (mmol/L)	Muscle glycogen (mmol/L)	Liver glycogen (mmol/L)
A	-	5.29±1.37	3.89±0.81	15.33±1.57
B	-	4.98±0.67	3.75±0.76	16.21±1.71
C1	100	4.88±0.94	4.27±0.68	17.98±2.15
C2	200	5.52±0.81	4.66±0.83 ^b	19.16±2.23 ^b
C3	400	5.42±0.93	4.82±0.20 ^{bb}	18.91±2.62 ^b

a: p<0.05, compared to sedentary group; aa: p<0.01, compared to control group; bb: p<0.01, compared to control group

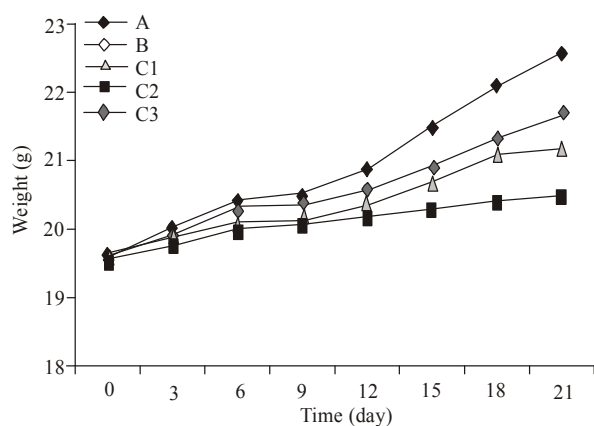


Fig. 2: Effect of jujube data polysaccharide on weight of rats

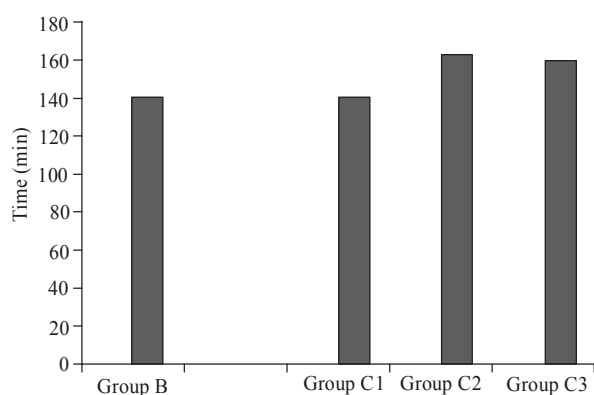


Fig. 3: Effect of jujube data polysaccharide on swimming time of rats

deviation. Whether the establishment of experimental model was effective was proved by comparing data in control and sedentary group, while the effect of jujube

date polysaccharide on various indexes of rats with fatigue caused by sports was explored by comparing data between experimental group and control group.

RESULTS

Effect of jujube date polysaccharide on weight growth of rats: Effect of jujube date polysaccharide on weight growth of rats is shown in Fig. 2.

Effect of jujube data polysaccharide of duration of loaded swimming to exhaust: Comparison of average value of duration of loaded swimming to exhaust is demonstrated in Fig. 3.

Exhaustion delay rate of rats in all sports groups is shown in Table 1. Exhaustive time delay rate of group C1, C2 and C3 was 2.87, 16.58 and 15.23%, respectively.

Effect of jujube data polysaccharide on blood lactic acid and blood urea nitrogen of rats: Effect of jujube data polysaccharide on blood lactic acid and blood urea nitrogen of rats is shown in Table 2.

Effect of jujube data polysaccharide on content of blood sugar muscle glycogen and hepatic glycogen of rats: Effect of jujube data polysaccharide on content of blood sugar muscle glycogen and hepatic glycogen of rats is shown in Table 3.

CONCLUSION

Effect of jujube data polysaccharide on weight of rats: Weight usually can reflect health condition of human body as development degree of skeleton and muscle and obesity degree have impact on weight. It

has been reported that, long-term high strength exercises brings severe influence on weight. It can be seen from Fig. 2 that, rats in control group and experimental group tends to have slower weight growth compared to sedentary group, indicating inhibitory effect of fatigue exercises on weight of rats; weight growth of rats in experimental group was more obvious compared to control group, but was still weaker than sedentary group. Results showed that, jujube data polysaccharide was effective in relieving slow weight growth caused by long-term training.

Effect of jujube data polysaccharide on duration of loaded swimming to exhaust: Duration of loaded swimming to exhaust is a common index reflecting athletic ability and improvement of athletic ability is the most powerful macroscopical reflection of improvement of anti-fatigue ability (Defeng *et al.*, 2012). Figure 3 demonstrated that, duration of loaded swimming to exhaust of rats in group C2 and C3 was longer than group B ($p < 0.05$); and duration of loaded swimming to exhaust of rats in group C1 was not significantly different with control group. That indicated that, jujube data polysaccharide with high dose can prolong duration of loaded swimming to exhaust.

Effect of jujube data polysaccharide on blood lactic acid and blood urea nitrogen: In strenuous exercise, energy substances consume in a large amount and muscle transforms from aerobic energy supply to anaerobic energy supply. Lactic acid comes from anaerobic metabolism of sugar within body. Excessive consumption of muscle glycogen can produce a large amount of lactic acid and accumulation of lactic acid in blood will directly or indirectly induce reduction of athletic ability of muscle, causing exercise induced fatigue. Lactic acid accumulation can lower PH value of muscle and blood, inhibit transmission of excitation of myoneural junction and activity of phosphofructokinase and delay or interrupt reaction of anaerobic glycolysis, thus delay synthesis of adenosine triphosphate (Deqi *et al.*, 2011; Guoqiang, 2007). Thus blood lactic acid is also one of the indexes reflecting fatigue of body.

Urea is the final product of protein and amino acid catabolism. Urea in plasma is usually represented by concentration of blood urea nitrogen. During sports, energy balance within body will change, i.e., consumption of muscle glycogen, blood sugar reduction and strengthened protein and amino acid catabolism. Especially in long term and high strength sports, blood urea nitrogen varies obviously, thus it is also considered as one of indexes assessing amount of exercise. Blood urea nitrogen is thought to be positively associated with somatic function and fatigue degree. Usually, content of blood urea nitrogen in serum increases as exercise

amount increases and body with better adaption ability to load produces less blood urea nitrogen (Tao *et al.*, 2013). In exhaustive sports, protein involves in energy supply, which increases the concentration of blood urea nitrogen. Results of this experiment proved that, jujube date polysaccharide in different doses had no obvious influence on content of blood urea nitrogen of exercise induced fatigue rats; but taking a certain dose of jujube date polysaccharide, rats could have significantly decreased content of blood urea nitrogen compared to exercise control group.

Effect of jujube data polysaccharide on blood sugar and carbohydrate storage of rats: Concentration of blood glucose usually keeps in a dynamic balance when body is normal, but the content would change significantly if pathological changes occur or body is influenced by environment and sports. Generally, concentration of blood glucose of rats remains at a relatively low level after sports. But the experimental object in this study was rats in rest state, thus content of blood glucose of rats in different groups varied not obviously.

Muscle glycogen and hepatic glycogen are the main source of skeletal muscles energy in exhaustive exercise. Their storage size in body is one of the important influence factors determining duration of loaded swimming to exhaust (Ye, 2009). Thus more storage of muscle glycogen and hepatic glycogen can provide more energy for contraction of muscle fiber, thereby delaying exercise induced fatigue. Results of this experiment demonstrated that, muscle glycogen and hepatic glycogen of rats taking medium and high dose of jujube data polysaccharide became higher compared to control group, i.e., a certain dose of jujube data polysaccharide can prolong duration of loaded swimming to exhaust of rats.

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