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The Research on the Influence of Jujube polysaccharide on Anti-fatigue in Endurance Training

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For researching the function of relieving fatigue of jujube polysaccharide, this paper group, middle dose group, high dose group and physiological saline group). Each time they were respectively feed 10g 10g/L, 20g/L, 40 g/L jujube polysaccharide liquid and 15ml/(kg.d) physiological saline. This experiment lasted 20 days. Measured mice’s biochemical Indicators including blood glucose, muscle glycogen, Liver glycogen and blood lactate. The results showed that: taking a dose of Jujube polysaccharide can increase muscle and liver glycogen content, reduce the accumulation of blood lactate after exhaustive exercise, maintain blood sugar constant and prolong time to exhaustion.The experiment proved that the Jujube polysaccharide has the function of anti-exercise fatigue, and developping Jujube polysaccharide has high value.

1. Introduction

Plant polysaccharides is a widely present in plants natural macromolecules. Because of its unique features, in recent years it has been widely used in clinical to enhance the body's immunity and enhance the body's antioxidant capacity and regulate the body's glucose metabolism. Jujube is rich in protein, amino acids, vitamins, alkaloids, saponins, minerals and polysaccharides. Currently studies on the impact of the jujube polysaccharide active ingredient on moving body fatigue resistance and glucose metabolism is still a blank at home and abroad.

Jujube is mainly produced in Shaanxi with adaptability. Its cultivation technique is simple, so it is widely grown in northern Shaanxi and other places (Gauthier, et al, 2006). Jujube polysaccharide component can improve the mice SOD, CAT and GSP-Px vitality, has better improving effect for mouse blood deficiency and blood deficiency, and having anti-ulcer effect (Morifujj M, et al, 2005). Jujube polysaccharide has these effects: enhance macrophage phagocytosis, promote lymphocyte transformation, anti-aging, and hepatoprotective (GESAN-GUIZIOU G, et al, 2007; Eli.D, et al, 2006).

Organism athletic ability is affected by training level, physical condition, sports environment, dietary nutrition and mental state, and many other factors. Regular exercise and physical activity can help blood circulation, enhance physical fitness. Conversely, prolonged exercise or overworked may become a factor (Benoit C, et al, 2008). Exercise-induced fatigue is due to physical and mental stress for a long time, the body has not effectively rest and adjusts, causing organism nervous, endocrine, immune dysregulation of various system functions (Brand MP., et al, 2004).

The rest of the paper is organized as follows. In Section 2, experimental data processing method is summarized briefly. In Section 3, Experiment materials and methodsis described. In Section 4, experiments are presented and the results are discussed. Finally, a conclusion is provided in Section 5.

2. Data processing method

2.1 t-test

A t-test is any statistical hypothesis test in which the test statistic follows a Student's t distribution if the null hypothesis is supported (Kerr Maeve A., et al, 2009).

In testing the null hypothesis that the population mean is equal to a specified value μ0, one uses the statistic

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$$t = \frac{\bar{x} - \mu_0}{s / \sqrt{n}} \tag{1}$$

where $\bar{x}$ is the sample mean, s is the sample standard deviation of the sample and n is the sample size. The degrees of freedom used in this test are n − 1.

2.2 Covariance

In probability theory and statistics, covariance is a measure of how much two random variables change together (Stevenson Emma J, et al, 2006).
The covariance between two jointly distributed real-valued random variables X and Y with finite second moments is defined as

$$\sigma(\mathrm{X},\mathrm{Y}) = \mathrm{E}[(\mathrm{X} - E[\mathrm{X}]) \bullet (Y - E[Y])] \tag{2}$$

where E[X] is the expected value of X, also known as the mean of X. By using the linearity property of expectations, this can be simplified to

$$\begin{aligned} Var(\mathrm{X}) &= \mathrm{E}[(\mathrm{X} - E[\mathrm{X}]) \bullet (Y - E[Y])] \\ &= \mathrm{E}[XY - X \bullet E[\mathrm{Y}] - Y \bullet E[\mathrm{X}] + E[\mathrm{X}] \bullet E[Y]] \\ &= \mathrm{E}[XY] - E[\mathrm{X}] \bullet E[\mathrm{Y}] - E[Y] \bullet E[\mathrm{X}] + E[\mathrm{X}] \bullet E[Y] \\ &= \mathrm{E}[\mathrm{X} \bullet \mathrm{Y}] - E[\mathrm{X}] \bullet E[\mathrm{Y}] \end{aligned} \tag{3}$$

However, when $\mathrm{E}[\mathrm{X} \bullet \mathrm{Y}] \approx E[\mathrm{X}] \bullet E[\mathrm{Y}]$, this last equation is prone to catastrophic cancellation when computed with floating point arithmetic and thus should be avoided in computer programs when the data has not been centered before.
The m×n cross covariance matrix (also known as dispersion matrix or variance–covariance matrix, or simply called covariance matrix) is equal to

$$\begin{aligned} \sigma(\mathrm{X},\mathrm{Y}) &= \mathrm{E}[(\mathrm{X} - E[\mathrm{X}]) \bullet (Y - E[Y])^T] \\ &= \mathrm{E}[\mathrm{X} \bullet \mathrm{Y}^T] - E[X] \bullet E[Y]^T \end{aligned} \tag{4}$$

3. Experiment materials and methods

3.1 Subjects

Jujube polysaccharide, physiological saline and mice.
Jujube polysaccharide extraction process was operated in the school food engineering laboratory.
Experimental animals ware 60 healthy male mice, two months old, weighing 22 to 26 grams.

3.2 Methods

60 mice were randomly divided into four groups (low dose group, middle dose group, high dose group and physiological saline group). Each time they were respectively feed 10g 10g/L, 20g/L, 40 g/L green beans sports drinks and 15ml/(kg.d).

3.3 Loading swimming test method

Every 30min after given the test sample, set mouse swimming in the swimming tank; Water depth is not less than 30cm, and water temperature is 25±3. Rat tail is loaded with 8% of body weight lead sheet, record the time from the mice began to swim to death as swimming time. Criteria are: the mice sank into water for eight seconds and unable to swim out, then immediately removed them and recorded swimming time.

4. Experimental results and analysis

Table 1 is the impact of jujube polysaccharide on muscle glycogen, and Table 2 is the impact of jujube polysaccharide on liver glycogen. Figure 1and 2 are the visualization of table1 and table 2.
Table 1 and 2 shows that the muscle glycogen content of low-dose exercise group in movement mid (30min) has significantly increased compared with the control group. Meanwhile the muscle glycogen content of low-dose exercise group in quiet state has significantly increased compared with that in movement mid (30min). The remaining cases have no statistically significant.

But for middle dose group and high dose group in quiet state, movement mid (30min) or movement late (60min), the muscle glycogen level and liver glycogen levels aresignificantly higher than the control group. This indicates Jujube polysaccharide can increase glycogen stores of mice in some given dose.

Table 1: The Impact of Jujube Polysaccharide on Muscle Glycogen (g/100g)

The group	Dose (g/L)	Quiet state	Movement mid (30min)	Movement late (60min)
Low dose group	10	0.51±0.08	0.45±0.09	0.47±0.12
Middle dose group	20	0.55±0.11	0.51±0.11	0.53±0.10
High dose group	40	0.61±0.09	0.64±0.08	0.62±0.09
Physiological saline group	15ml/kg.d	0.47±0.12	0.41±0.11	0.44±0.10

Table 2: The Impact of Jujube Polysaccharide on Liver Glycogen (g/100g)

The group	Dose (g/L)	Quiet state	Movement mid (30min)	Movement late (60min)
Low dose group	10	2.11±0.34	2.01±0.36	2.04±0.38
Middle dose group	20	2.34±0.12	2.18±0.48	2.26±0.25
High dose group	40	2.46±0.28	2.33±0.39	2.39±0.31
Physiological saline group	15ml/kg.d	1.98±0.36	1.84±0.41	1.88±0.34

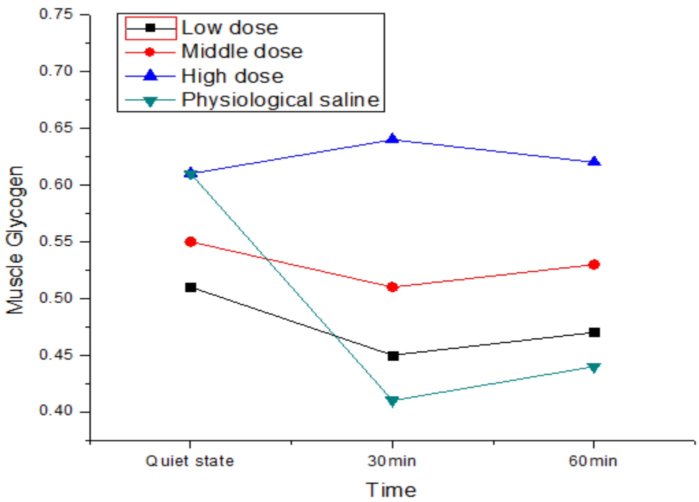

Figure 1: The Impact of Jujube Polysaccharide on Muscle Glycogen (g/100g)

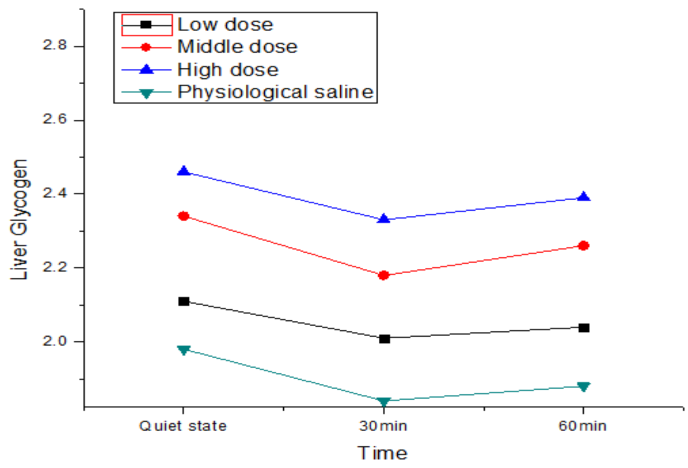

Figure 2: The Impact of Jujube Polysaccharide on Liver Glycogen (g/100g)

Table 3 is the impact of jujube polysaccharide on glucose. Figure 3 is the visualization of table 3. Table 3 shows that in movement late (60min) glucose content of physiological saline group and low dose group is significantly decreased compared with in quiet state.

Glucose recovery after exercise shows that only high-dose group and the control group have significantly increased differences. Before the rest of the group has no significant difference ($p > 0.05$) compared to in quiet state and movement late (60min).

Table 3: The Impact of Jujube Polysaccharide on Glucose (mmol/L)

The group	Dose (g/L)	Quiet state	Movement mid (30min)	Movement late (60min)
Low dose group	10	7.24±1.23	6.45±0.89	6.86±1.12
Middle dose group	20	7.14±1.01	6.68±0.95	6.93±0.96
High dose group	40	7.28±1.34	6.81±1.02	7.06±0.86
Physiological saline group	15ml/kg.d	7.04±0.86	6.31±0.84	6.77±1.00

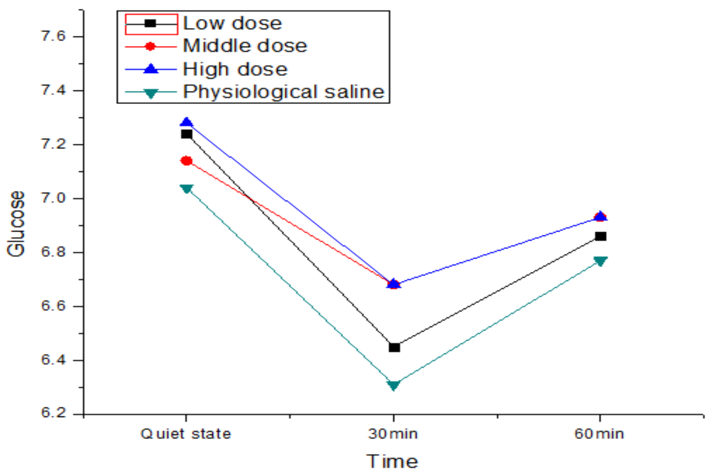

Figure 3: The Impact of Jujube Polysaccharide on Glucose (mmol/L)

Table 4 is the impact of jujube polysaccharide on liver glycogen. Figure 4 is the visualization of table 4. The Figure 4 shows that in movement mid (30min) there is significant increase of lactic acid of all groups of mice ($p < 0.01$) compared with quiet state. The lactic acid concentration of each experimental group mice reduced in different degree compared to the control group ($p < 0.05$). There is no significant difference of lactic acid concentration in each group between quiet state and movement late (60min).

Table 4: The Impact of Jujube Polysaccharide on Lactic Acid (mmol/L)

The group	Dose (g/L)	Quiet state	Movement mid (30min)	Movement late (60min)
Low dose group	10	3.15±0.46	11.84±1.05	3.84±0.91
Middle dose group	20	3.45±0.38	11.06±0.76	4.21±0.84
High dose group	40	3.72±0.52	10.15±1.12	4.58±0.72
Physiological saline group	15ml/kg.d	3.31±0.41	12.56±0.86	4.36±0.86

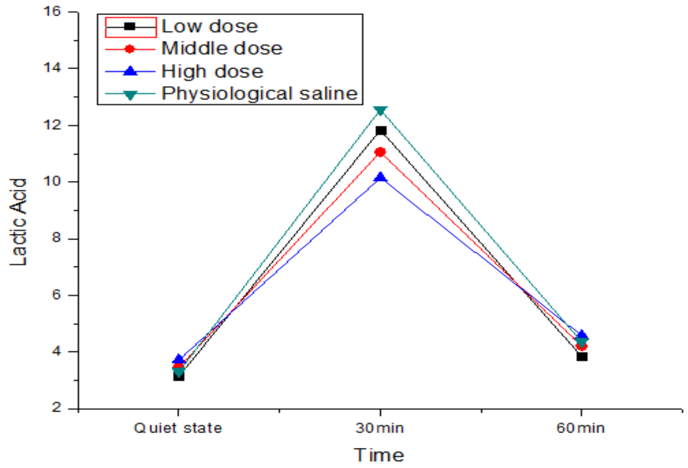

Figure 4: The Impact of Jujube Polysaccharide on Lactic Acid (mmol/L)

5. Conclusions

This experiment lasted 20 days. Measured mice's biochemical Indicators including blood glucose, muscle glycogen, Liver glycogen and blood lactate. The results showed that: taking a dose of Jujube polysaccharide can increase muscle and liver glycogen content, reduce the accumulation of blood lactate after exhaustive exercise, maintain blood sugar constant and prolong time to exhaustion.The experiment proved that the Jujube polysaccharide has the function of anti-exercise fatigue, and developping Jujube polysaccharide has high value. It is desirable to further apply IABC algorithms to solving those more complex real-world optimization problems and it will be our further work.

In the long high-intensity exercise, a lot of depleted glycogen and accumulation of lactic acid can induce the occurrence of exercise-induced fatigue. From in this study the exhaustive swimming time of mice in each group, the exhaustive swimming time mouse of high doses Jujube Polysaccharide is significantly improved compared to the control group. Liver glycogen and muscle glycogen are an important energy substances for movement. Its reserves size are directly related to the delay fatigue. When the high-intensity training, glycogen output not only maintains blood glucose constant, and timely remedy muscle glycogen depletion to maintain activity levels.

Experimental results show that before and after exercise, for the mice taking the low and high dose jujube polysaccharide, liver glycogen and muscle glycogen reserves had significantly improved compared with the control group. This shows that Jujube Polysaccharide possibly prolongs the time exhaustion by increasing the body's glycogen stores. For the mice takingdifferent dose jujube polysaccharide, liver glycogen and muscle glycogen recovery rate are improved with varying degrees compared to the control group.

Under normal circumstances, the body's blood sugar levels maintain a dynamic constant. The results showed that after takingdifferent doses of Jujube Polysaccharide, mouse blood lactate concentration has no significant effect on recovery before and after exercise. However, immediately after exercise compared with before

exercise, there are different degrees of decline. This shows that: taking a dose of Jujube Polysaccharide mitigates the extent of lactic acid accumulation in the long high-intensity exercise for mice.
The experiment proved that the Jujube polysaccharide has the function of anti-exercise fatigue, and developping Jujube polysaccharide has high value.

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