ISSN: 2710-5954 (Online)
CODEN: MSJABY

Malaysian Sports Journal (MSJ)

DOI: http://doi.org/10.26480/msj.01.2021.06.10

RESEARCH ARTICLE

STUDY ON THE EFFECT OF BLUEBERRY POLYSACCHARIDE ON THE CHEMICAL EFFECT OF ANTI-MOVEMENT FATIGUE IN PHYSICAL TRAINING

Kadkhodaie Abasali*, Khaleghi Ali

Faculty of Physical Education and Sport Sciences, University of Tehran, Iran
****Corresponding Author Email: zacknoah2020@protonmail.com***

ARTICLE DETAILS

Article History:

Received 08 May 2021
Accepted 10 June 2021
Available online 13 June 2021

ABSTRACT

Fatigue (fatigue) refers to the ability to work due to the activity and the phenomenon of body function temporarily reduce, the improvement of sports endurance is the ability to resist fatigue strengthen the strong macro performance. The premise of body exercise endurance is enhancing energy reserves is enough, the more energy supply, the more durable endurance will be. BPs can reduce the content of BLA, BUN and increase HG, MG content in different degrees, these changes may be the important material base of its role of expressing anti-fatigue functions. Based on this, the time of exercise endurance of high-dose BPs group is extended than that of the normal control group at 14.3% ($P<0.05$), high-dose BPs group also effectively increased the SOD and LDH activity in body, and significantly reduced BUN, BLA and MDA content in body after strenuous exercise, which showed that high doses of BPs have strong ability to remove free radicals. Blueberry polysaccharides can increase the ability of aerobic metabolism and exercise endurance in body, so after completing the same exercise load, blood lactic acid content is relatively lower than the control group, thus able to resist the role of sports fatigue strength.

KEYWORDS

Polysaccharides, metabolism, blood lactic acid

1. INTRODUCTION

Blueberry is a kind of strong cold resistance of wild plants, native to North America, Scotland, and Russia. Blueberry fruit is not only sweet and sour moderate, good flavour, but also containing a lot of things that are good for human health, such as rich vitamins, dietary fibre, protein and mineral nutrient elements including antioxidants and tannic acid, folic acid, antibacterial ingredients, etc. Therefore, it is often known as the "king of berries".

Research abroad on the active ingredient in blueberry has focused on anthocyanin, various physiological functions of anthocyanin extract was studied, and some processing on its antioxidant capacity (Li Yingchang. et al, 2008). The functional sex of the flavonoids in blueberries is still studied. Studies on the activity of polysaccharide blueberries are not reported, water extract-alcohol precipitation method was used in the experiment to extract polysaccharides from blueberry, after preliminary purification, research on polysaccharide of its vitro antioxidant activity and bacteriostatic is taken, to provide a reference for the production and application of blueberry polysaccharides.

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. 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 deregulation of various system functions.

After the big intensity and large amount of exercise training, athletes often have varying degrees of overtraining response, decreased exercise capacity, loss of appetite, sleep disturbances, tired of training, poor excitability, general fatigue, depression and other symptoms. Be seen, decreased exercise capacity caused by muscle maintaining a certain state and keeping systolic and diastolic is the main factor of sports fatigue. Multi-organ, multi-system dysfunction is the essence of sports fatigue.

2. EXTRACTION AND PURIFICATION OF POLYSACCHARIDE

2.1 Extraction of Polysaccharide

Extraction and separation of polysaccharide including: Degrease ~ solvent extraction~ deproteinization~ decolouration processes, etc.

Degrease: the polysaccharide extraction materials degreasing first, solvent extraction, general or dilute salt water, dilute alkali, dilute acid extraction under different temperatures.

Deproteinization: Through organic solvent precipitation polysaccharide, often contain more protein will need to be removed.

Decolourization: coarse polysaccharide often contains some pigment (free combination dyes and pigments), adopting different methods according to different properties.

2.2 Purification of polysaccharides

Methods of polysaccharide purification are usually the following kinds:

(l) Division precipitation method: According to the polysaccharide in different concentrations of low alcohol, ketone with different solubility

Quick Response Code	Access this article online	
	Website: www.mysj.com.my	**DOI:** 10.26480/msj.01.2021.06.10

Cite The Article: Kadkhodaie Abasali, Khaleghi Ali (2021). Study on The Effect of Blueberry Polysaccharide on The Chemical Effect of Anti-Movement Fatigue in Physical Training. *Malaysian Sports Journal , 3(1): 06-10.*

properties, from small to large in proportion to alcohol, ketone (such as methanol, ethanol and acetone) division of the precipitation. This method is suitable for the separation of various solubility large difference of the polysaccharide.

(2) Salt fractionation method: Different polysaccharide has different solubility in different salt concentrations. Common salting-out agents are s sodium chloride, potassium chloride and ammonium sulphate etc., and sulphuric acid amine is the best.

(3) Metal complex method: polysaccharide can form complex ions and precipitation with copper, barium, calcium, lead sheath.

2.3 Materials and reagents

Fresh blueberry without freezing injury, bought in the fruit supermarket. D-galactose Sigma-Aldrich companies in the United States; Blood urea nitrogen (BUN) kit, blood lactic acid (BLA) kit, liver glycogen, hepatic glycogen (HG) kit, muscle glycogen (MG) kit, malondialdehyde (MDA) kit, superoxide dismutase (SOD) kit, lactate dehydrogenase (LDH) kit, Nanjing building biological engineering research institute; Other reagents were pure homebred analysis. Kunming body 50, SPF level, male and female are both half, 20~22g body quality.

2.4 Instrument and equipment

DHG-9240A thermostatic drum wind drying oven, DK-8D three holes thermostatic water tank, Shanghai Qixin scientific instrument co. LTD. Ultrasonic cleaning machine, ningbo xingzhi biological technology co. LTD. Refrigerated centrifuge Beckman companies in the United States; UV-2450 ultraviolet-visible spectrophotometer Shimadzu.

2.5 Preparation of blueberry polysaccharides

Weigh and blueberry fruit 120g, pulping after quick-freeze in -80 °C for 10 min after cleaning the materials, add a small amount of distilled water after using microwave assisted extraction. After the suction filtration filtrate is made to centrifuge at 5 000 r/min in 15 min. Add a small amount of water dissolving pulp after repeated extraction twice, extracted the supernatant fluid of merger blending, rotary evaporation solution all moisture evaporation. Add 95% ethanol, 100% ethanol and acetone and process respectively, placed in 4°C for 24h, centrifuge at 3000 r/min in 10 min, use Sevag method (SEVAG M G. *et al*, 1938) in addition to protein, which will get the blueberry precipitation after freeze drying coarse polysaccharide.

2.6 Conditions and grouping of experimental animals

Before the trial, 50 body will be in the experimental environment with based feed for 1 week, and then they are randomly divided into 5 groups according to body quality (male and female half), they are respectively the normal control group, model control group, low-dose, medium-dose and high-dose BPs groups. Intraperitoneal injection of normal control group with 100 mg/ (kg·d) (with body quality meter, similarly hereinafter) physiological saline, intraperitoneal injection of the rest of the four groups of 100 mg/ (kg·d) D-galactose, cycle for 60d. At the 41th days, normal control group is gavaged with gastric distilled water, model control group are injected of D-galactose in intraperitoneal and lavage distilled water at the same time, the low, medium and high dose groups of BPs are injected of D-galactose in intraperitoneal and lavage distilled water at the same time in 100, 200, 400 mg/ (kg·D) dose of BPs, continuous dosing 20d. Groups are given basic feed and free drinking water.

2.7 Exhaustion swimming time of body

30 min after the last treatment experiment. After each body are weighed, the rat tail root are born load of 5% weight lead sheath skin, the degree of tightness of fixation should be appropriate, put groups of body respectively in 10 thermostatic water box, with the water temperature 25°C and the water depth (20+5) cm. Record the body swimming time with a stopwatch when body began to sink under the water after 10 s not surfaced as swimming exhaustion time/min. Some body floating in the water not to swim, which will make swimming significantly prolonged, therefore, in order to get reliable results, every body must be made continued to swim, stir gently around sticks available in body.

2.8 Preparation and testing test sample

After exhaustion swimming experiment, pull eyeball and draw blood, centrifuge at 4000 r/min in 10 min, and take supernatant on standby. All processing are completed under the condition of 4°C. The BUN, BLA, HG, MG, MDA, SOD and LDH kit description combined with ultraviolet-visible spectrophotometer determination of each index respectively.

The basic steps of Harmony Search Algorithm are as follows:

Step 1: Setting of the basic parameters

We have to give some value for these parameters, such as the variable number N, the range for each variable, the maximum iterations $I_{\max}$, the harmony memory size S_{HM}, *HMCR*, *PAR* and *BW*.

Step 2: Harmony memory initialization

S_{HM} solution vectors are randomly generated according to the variable range for each variable. Namely,

$$HMV=\left[\begin{array}{c|c} \boldsymbol{x}^1 & f(\boldsymbol{x}^1) \\ \boldsymbol{x}^2 & f(\boldsymbol{x}^2) \\ \vdots & \vdots \\ \boldsymbol{x}^{S_{HM}} & f(\boldsymbol{x}^{S_{HM}}) \end{array}\right]=\left[\begin{array}{cccc|c} x_1^1 & x_2^1 & \cdots & x_N^1 & f(\boldsymbol{x}^1) \\ x_1^2 & x_2^2 & \cdots & x_N^2 & f(\boldsymbol{x}^2) \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_1^{S_{HM}} & x_2^{S_{HM}} & \cdots & x_N^{S_{HM}} & f(\boldsymbol{x}^{S_{HM}}) \end{array}\right] \quad (1)$$

Step 3: Generating new solutions

In this step, we should create a new harmony $\boldsymbol{x}^{new}=\left[x_1^{new},x_2^{new},\ldots,x_N^{new}\right]$. $x_i^{new}(i=1,2,\ldots,N)$ can be generated by 3 ways, i.e., learning the harmony memory, tone trim, and random selecting. Hence, we have:

$$x_i^{new}=\begin{cases} x_i^j,\ j\in\{1,2,\ldots,S_{HM}\},\ if\ \ rand<HMCR \\ \bar{x}_i\in X_i,\ otherwise \end{cases} \quad (2)$$

where X_i is the range of x_i and *rand* is a random number which belongs to [0,1]. As for x_i^{new} from harmony memory, we have

$$x_i^{new}=\begin{cases} x_i^{new}+rand*BW, & if\ \ rand<PAR(\text{Continuous}) \\ (k+\lambda)*x_i^{new},\lambda\in[-1,1], & if\ \ rand<PAR(\text{Discrete}) \\ x_i^{new}, & otherwise \end{cases} \quad (3)$$

where *PAR* is the pitch adjusting rate, *BW* is band width.

Step 4: Updating the harmony memory

In this step, we should evaluate the new harmony. If the new harmony is better than the worst harmony in the memory, the worst harmony is replaced with the new harmony, i.e.,

$$\boldsymbol{x}^{worst}=\boldsymbol{x}^{new},\ if\ \ f\left(\boldsymbol{x}^{new}\right)<f\left(\boldsymbol{x}^{worst}\right) \quad (4)$$

Step 5: Checking the iterations

We should check whether the number of iterations is more than $I_{\max}$. If not, then repeat Steps 1-4; otherwise, we should finish the process, and output the result.

In the field of artificial intelligence, a genetic algorithm (GA) is a search heuristic that mimics the process of natural selection. Genetic Algorithm is an adaptive random search method which derives from the genetics and natural selection in biological evolution. GA is first proposed by John Holland in 1970s.

The basic algorithm under the OPM3 model is shown in the following:

$$\gamma_i(\bar{k}_i,\omega)=\frac{1}{\rho_0\omega^2}\left(\frac{e_{15}^0}{\eta_{11}^0}\right)^2\frac{\beta_\perp^2}{\bar{k}^2-\beta_\perp^2}m_i \quad (6)$$

$$g_{ik}(\bar{k},\omega)=-\frac{1}{\eta_{11}^0}\frac{1}{\bar{k}^2}+\frac{1}{\rho_0\omega^2}\left(\frac{e_{15}^0}{\eta_{11}^0}\right)^2\frac{\beta_\perp^2}{\bar{k}^2-\beta_\perp^2}, \quad (7)$$

In which,

$$\alpha^2=\frac{\rho_0\omega^2}{C_{11}^0}, \quad (8)$$

$$\alpha^2=\frac{\rho_0\omega^2}{C_{66}^0},\beta_\perp^2=\frac{\rho_0\omega^2}{C'_{44}}, \quad (9)$$

$$C'_{44}=C_{44}^0+\frac{(e_{15}^0)^2}{\eta_{11}^0} \quad (10)$$

Rewrite again Eq. (1) as

$$\begin{aligned}\hat{f}_H^\alpha(x)&=\frac{1}{\Gamma(1+\alpha)}\int_{-\infty}^{\infty}\frac{f(t)}{(t-x)^\alpha}(dt)^\alpha\\&=\frac{1}{\Gamma(1+\alpha)}\int_{-\infty}^{\infty}f(t)g(x-t)(dt)^\alpha\\&=f(x)*g(x),\end{aligned} \quad (11)$$

$$\partial_j(C_{ijkl}\partial_k u_l+e_{kij}\partial_k\varphi)-\rho\ddot{u}_i=0 \quad (12)$$

$$\partial_j(e_{ijkl}\partial_k u_l-\eta_{kij}\partial_k\varphi)=0 \quad (13)$$

The linear equation can be expressed into the following simplified forms:

$$L(\nabla,\omega)f(x,\omega)=0 \quad (14)$$

$$L(\nabla,\omega)=T(\nabla)+\omega^2\rho J \quad (15)$$

So we get the PR value as the following:

$$PR(u)=\sum\frac{PR(V)}{L(V)} \quad (16)$$

$$L_k=\frac{d_e}{\sum_{e=1}^{n}d_e} \quad (17)$$

To calculate the parameters in above equations, then we have:

$$\Lambda_{ik}(k,\omega)=k_jC_{ijkl}^0k_k-\rho_0\omega^2\delta_{il},\quad h_i(k)=e_{kil}^0k_kk_l,$$
$$h_l^T=e_{ikl}^{0T}k_ik_k,$$

$$\lambda(k)=\eta_{ik}^0k_ik_k \quad (18)$$

$$\frac{1}{2\pi}\int_{-\infty}^{\infty}e^{-ik_3x'_3}dx'_3=\delta(k_3) \quad (19)$$

$$s(X\rightarrow Y)=\frac{\sigma(X\cup Y)}{N} \quad (20)$$

$$c(X\rightarrow Y)=\frac{\sigma(X\cup Y)}{\sigma(X)} \quad (21)$$

Its local fractional Hilbert transform, denoted by $f_x^{H,\alpha}(x)$ is defined by

$$\begin{aligned}H_\alpha\{f(t)\}&=\hat{f}_H^\alpha(x)\\&=\frac{1}{\Gamma(1+\alpha)}\oint_R\frac{f(t)}{(t-x)^\alpha}(dt)^\alpha\end{aligned} \quad (22)$$

Where X is real and the integral is treated as a Canchy principal value, that is,

$$\begin{aligned}&\frac{1}{\Gamma(1+\alpha)}\oint_R\frac{f(t)}{(t-x)^\alpha}(dt)^\alpha\\&=\lim_{\varepsilon\to 0}[\frac{1}{\Gamma(1+\alpha)}\int_{-\infty}^{x-\varepsilon}\frac{f(t)}{(t-x)^\alpha}(dt)^\alpha+\\&\frac{1}{\Gamma(1+\alpha)}\int_{x+\varepsilon}^{\infty}\frac{f(t)}{(t-x)^\alpha}(dt)^\alpha]\end{aligned}$$

3. RESULTS AND DISCUSSION

Test sports endurance of body with swimming method. The effects of blueberry polysaccharides on sports endurance of body are shown in Figure 1.

3.1 Effects of BPs on Aged Body of Exhaustion Swimming Time

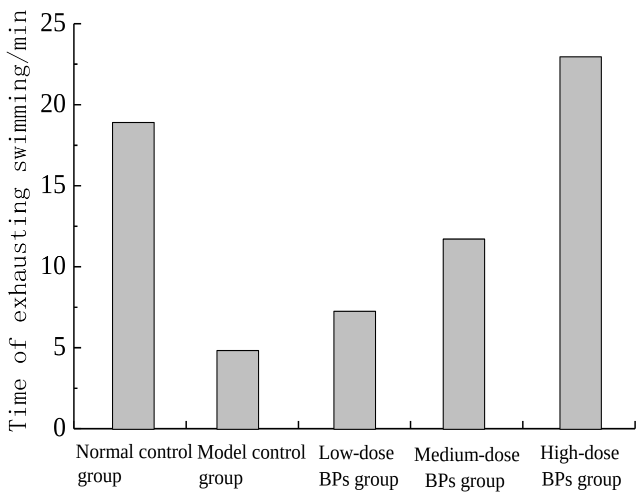

Figure 1: Result of Exhaustive Swim of Aged Body

The time of continuous movement until exhausting and survival time of hypoxia condition can reflect the body's endurance, which is the relatively objective index to evaluate fatigue state. Methods building aging animal models at present mainly include injection of D-galactose, ozone damage, removing thymus, using older animals, etc. As shown in Figure 1, normal control group and different exhaustion swimming time in body BPs dose group are higher than that of model control group, the BPs low dose group compared with model control group has no significant difference (P >

0.05), and the rest of the group rre significantly higher than that of model control group (P<0.05). The experimental results show that exhaustion swimming time in body and BPs dose were positively correlated, showing that blueberry polysaccharides can enhance the endurance of the movement of body, has the anti-fatigue function. BPs high dose group had a significantly higher exhaustion swimming time of body in BPs, low dose group (P<0.05). Results show that blueberries polysaccharide can significantly improve the sport ability of aging body, delay the onset of fatigue.

3.2 Effect of BPs on Aging Body of Related Physiological Indexes like BUN and BLA

After the experimental group rats were filled and fed with blueberry polysaccharides 15 d. The results of BUN and BLA are shown in Table 1. The results shows that the content of serum urea nitrogen dose group were lower than the control group, and extremely significant difference (P<0.01), suggesting the blueberry polysaccharides have lower serum urea nitrogen.

Table 1: Effect of BPs on BUN and BLA of Aged Body

Group	Dose(mg/（kg·d）)	BUN content /（m mol/L）	BLA content (mg/l00ML)
Normal control group	100 normal saline	13.26±1.78	14.02±0.66
Model control group	0	15.32±2.05	19.76±1.53
Low-dose BPs group	200	13.75±1.96	18.01±0.94
Medium-dose BPs group	300	13.70±2.36	15.97±0.27
High-dose BPs group	500	13.62±1.84	14.15±0.99

When glycogen is in a large amount of consumption, biological activity reduced, resulting in the slow and tired of body. Therefore reserve original conducive to reduce the amount of protein and sugar catabolism of nitrogen compounds, improve the body's endurance. Lack of oxygen supply relatively caused by strenuous exercise of body will increase metabolites of lactic acid etc., leading to muscle contraction efficiency drop. Therefore, the changing rule of the BLA content also appears similar, Contents of BLA of low-dose, medium-dose and high-dose BPs groups compared with model control group reduced by significant differences (P<0.05).

Determination Results of Liver Glycogen and Muscle Glycogen

It can be seen from Table 2 that after the rats of all experimental groups were filled and fed with blueberry polysaccharides 15 for days. Liver glycogen content increased significantly, it is extremely significant difference compared with the control group (P<0.01).

Table 2: Effect of BPs on HG and MG of Aged Body

Group	Dose(mg/（kg·d）)	HG content /（mg/g）	MG content（mg/g）
Normal control group	100 normal saline	30.28±4.87	1.80±0.21
Model control group	0	21.16±3.16	0.95±0.08
Low-dose BPs group	200	34.15±4.88	1.22±0.07
Medium-dose BPs group	300	36.13±3.91	1.57±0.17
High-dose BPs group	500	35.59±4.69	1.81±0.10

Table 2 shows that different BPs dose group of HG content is higher than that of normal control group. Compared with the normal control group, the HG content in three dose group were significantly increased (P<0.05). There is evidences that (TAN Wei. *et al*, 2012), after high intensity exercise of 2h, MG is almost exhausted, because MG reduced gradually, the HG hydrolysis increased to maintain the stability of blood sugar. From the results, each BPs dose group can effectively enhance the ability of continuous movement in body.

Numerous studies have found that (RAY A D. *et al*, 2013; DUQUETTE A M. *et al*, 2010) short time high strength caused by muscle fatigue is because the energy storage materials ATP in muscle are in short supply, when ATP decreased to a certain level, the glycolysis of MG will be carried out in ATP synthesis, the process of which will be accompanied by the accumulation of lactic acid, causing the rise of hydrogen ion concentration in the body, drop of muscle pH, eventually lead to the decrease of muscle contraction ability. The experiment confirmed that the low-dose BP group, middle-dose BP group, and high-dose BP group three dose groups of HG content were significantly higher than that of normal control group (P<0.05), suggesting BPs can increase reserve of glycogen, provide the body with energy supplies, relieve physical fatigue and enhance the effect of exercise endurance (MILLER. *et al*, 1996; Roussy. *et al*, 2005; Santos. *et al*, 2010).

3.3 Determination Results of MDA and Enzymes Dehydrogenase Activity

The experimental group rats were fed blueberries polysaccharide for 15 days, test results of MDA, SOD and LDH activities are shown in Table 3.

Table 3: Effect of BPs on MDA, SOD and LDH of Aged Body				
Group	Dose(mg/（kg·d）)	LDH vitality/（U/mL）	SOD vitality/（U/mL）	MDA content（mg/g）
Normal control group	100 normal saline	597.55. ±42.15	302.32±19.32a	22.24±1.10
Model control group	0	539.55. ±37.30	250.01±13.74d	26.35±1.58a
Low-dose BPs group	200	585.09. ±42.66	311.27±24.47a	25.40±1.32ab
Medium-dose BPs group	300	741.24. ±76.62	338.65±19.00b	23.29±1.04
High-dose BPs group	500	1027.61±98.84	364.07±21.14c	22.33±1.02c

The results showed that blueberry polysaccharides lactate dehydrogenase activity of each dose group were higher than that of normal control group, medium-dose group significant difference ($P<0.05$), high-dose group of extremely significant difference ($P<0.01$), suggesting the blueberry polysaccharides can increase the activity of MDA, SOD and LDH. Compared with the serum SOD activity of model control group, low- dose, medium-dose and high-dose BPs groups had increased by 24.5%, 35.4% and 45.6% respectively ($P<0.05$), suggesting that BPs to adjust the serum SOD effect is very obvious. In addition, the serum LDH activity also significantly increased with the increase of the BPs dose, but compared with BPs, high dose group is no significantly different from serum LDH, which reflecting the effect of BPs dose on the activity of LDH. The above results show that the BPs has good antioxidant activity of body, not only significantly increase the antioxidant activity of the enzyme system in the body, but also effectively remove free radicals and prevent cell membrane lipid peroxidation, perhaps this is one of the key mechanism of BPs has the anti-fatigue function.

4. Discussion

This topic introduces functions, extraction and purification of polysaccharides and focuses on the effect of blue polysaccharides (BPs) on sport capacity, anti-fatigue effect and related physiological indexes in aged body induced by D-galactose was investigated. Water extract-alcohol precipitation method was used in the experiment to extract polysaccharides from blueberry, after preliminary purification, research on polysaccharide of its vitro antioxidant activity and bacteriostasis is taken, to provide a reference for the production and application of blueberry polysaccharides. Body were randomly divided into normal control group, aged model group, low-dose BP group, middle-dose BP group, and high-dose BP group. After the administration of BPs for 20 consecutive days, the exhaustive swimming time and fatigue indexes were determined. The results showed that BPs could extend the exhaustive swimming time, decrease the content of BUN, BLA and MDA, and obviously increase the reservation of HG, MG, SOD and LDH. To conclude, BPs has good anti-fatigue effect. This study may provide theoretical evidence for the development of anti-fatigue drugs from BPs.

References

Duquette A M, Andrews D M, 2010. Tibialis Anterior Muscle Fatigue Leads To Changes In Tibial Axial Acceleration After Impact When Ankle Dorsiflexion Angles Are Visually Controlled [J]. Human Movement Science, 29(4): 567-577.

Li Yingchang, Meng Xianjun, 2008. Influence Of Main Material Content And Dealing Method In Blueberries On Anthocyanin [J]. Journal Of Food Science, 29 (5): 163-164.

Miller N J, Sampson J, Candelasi P, Et al, 1996. Antioxidant Activities Of Carotenes And Xanthophylls [J]. Febs Letters, 384:240-242.

Ray A D, Udhoji S, Mashtare T L, 2013. A Combined Inspiratory And Expiratory Muscle Training Program Improves Respiratory Muscle Strength And Fatigue In Multiple Sclerosis [J]. Archives Of Physical Medicine And Rehabilitation, 94(10): 1964-1970.

Roussy J, Chastellan P, Vooren M, Et al, 2005. Treatment Of Ink-Containing Wastewater By Coagulation/flocculation Using Biopolymers[J]. Water Sa, 31 (3):369-376.

Santos Jlc, Geraldes V, Velizarov S, Et al, 2010. Characterization Of Fluid Dynamics And Mass-Transfer In An Electrochemical Oxidation Cell By Experimental And Cfd Studies[J]. Chem. Eng. J., 157(2-3): 379–392.

Sevag M G, Lackman D B, Smolens J, 1938. The Isolation Of Components Of Streptococcal Nucleoproteins In Serologically Active Form[J]. Journal Of Biological Chemistry, 124: 425.

Tan Wei, Yu Keqiang, Liu Yanyan, Et al, 2012. Anti-Fatigue Activity Of Polysaccharides Extract From Radix Rehmanniae Preparation [J]. International Journal Of Biological Macromolecules, 50(1): 59-62.