Original Article

Role of physical activity on the adaptation changes of chemism of an antioxidant system of young athletes

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Abstract:

Statement of a Problem Increase secondary heptane and isopropanol of soluble products of perokisny oxidation of lipids and antioxidant enzymes (a catalase, superoxide dismutase) in an organism of young athletes at a stage of training process is established. **Organization and Methods of a Research** Two groups of young athletes participated in a research. Girls sportswomen of 14-16 years (1-2 categories) doing track and field athletics sprint and having a training experience not less than 2 years in number of 20 people entered into the first group of athletes. The young athletes who are engaged in a triple jump, the same age, as the girl of the first group in number of 10 people entered into the second group of athletes. The condition of the perokisny oxidation of lipids (POL) was estimated according to contents primary (diyenovy conjugates of hydroperoxides) and secondary (ketodienes and spryazhenny triyena) products of a lipidic peroksidation at heptane-izopropanolnykh saliva extracts. Contents primary and by-products of POL was defined by I.A. Volchegorsky's method (1989, 2000). Superoxide dismutases determined activity by S. Chevri's method, etc. (1985), catalases – N.S. Mamontov's method & et. al. (1994). **The Purpose of the Research** – to study influence of physical activities on the maintenance of products of perokisny oxidation of lipids at teenagers during the competitive period of sports preparation. **Results & Conclusions** In a macrocycle of training process with increase in physical activity activation of perokisny oxidation of lipids with change of ratios of by-products of a peroksidation both at sprinters, and at the athletes who are engaged in a triple jump was observed. Also increase in power of antioxidant systems was observed that is expressed in reliable increase in activity of a catalase and superoxide dismutases at both groups of athletes.

Key Words: Perokisny Oxidation of Lipids (POL); Antioxidants; Catalase; Superoxide Dismutase; Sprinters; Triple Jump

Introduction

The biochemical adaptation of an organism to muscular activity happening in the course of the training extends to all functional systems concerning ensuring motive activity including on antioxidant systems. Adaptation changes of chemism of these systems and bodies have the same genesis, as adaptation changes in muscles, which generate the processes happening during muscular activity [Meerson, 1985; Pavlova, 1990, 1992].

The high activity of products of free radical oxidation defines normal their regulatory physiological action consisting, eventually, in reversible change of a functional condition of biomembranes. Activation of perokisny oxidation of lipids is the major link in pathogenesis of the most various pathological states [Fugila, 2002].

In cages of an organism, there is a continuous process of free radical oxidation of lipids. Products the POL participate in regulation of functioning of biological membranes of cages and in the speed of their updating. The stress level caused by training loads the more activation simpatoadrenalovy and hypothalamic-pituitary-adrenal is higher than a system, the POL level in an organism is higher [Pavlova, 1996].

Development of free radical oxidation of lipids in cages is constantly proceeding process being under control of regulatory systems [Baraboy, 1991; Zenkov, Lankin & Menshikova, 2011]. In physiological processes, products the POL participate in regulation of function of biological membranes and speed of their updating [Vladimirova & Archakov, 1972; Lankin & Kotelevtseva, 1986; Grigorieva, 2003].

Under the influence of the factors of the environment leading to activation simpatoadrenalovy and hypothalamic-pituitary-adrenal systems, the POL level increases [Baraboy, 1991; Pavlova, 1992; Dyatlov, et. al., 1997; Sazontova & Archipenko, 2007; Flerov, et. al., 2008].

Increase in activity of antioxidant enzymes is the most important component of formation of a structural trace of adaptation to physical activities [Powers & Lennon, 1999; Vincent, et. al., 2000]. Therefore studying of specifics of changes of maintenance of products the POL in an organism of young athletes in response to training physical activities and also a research of influence on these changes of degree of their adaptedness to muscular activity is represented relevant.

Material & Methods

Participants

Two groups of young athletes participated in a research. Girls sportswomen of 14-16 years (1-2 categories) doing track and field athletics sprint and having a training experience not less than 2 years in number of 20 people entered into the first group of athletes. The control group was made by 20 girls of 14-16 years carried to the I and II groups of health, studying according to the main program of educational institutions (3 hours of physical culture a week). Researches were conducted at the end of autumn and winter and spring and summer special and preparatory stages of training process. The young athletes who are engaged in a triple jump, the same age, as the girl of the first group in number of 10 people entered into the second group of athletes.

Purpose, Methods and Procedures

The Purpose of the Research – to study influence of physical activities on the maintenance of products of perokisny oxidation of lipids at teenagers during the competitive period of sports preparation.

Methods and Procedures of the Research

For saliva sampling the mouth was previously rinsed with physiological solution, and then within 3-5 minutes in test tubes collected about 2 ml of saliva. Tests of saliva centrifuged at 3000 revolutions per minute within 15 minutes. For further researches used nadosadochny liquid.

Perekisny Oxidation of Lipids

The condition of the perokisny oxidation of lipids (POL) was estimated according to contents primary (diyenovy conjugates of hydroperoxides) and secondary (ketodienes and spryazhenny triena) products of a lipidic peroksidation at heptane-izopropanolnykh saliva extracts.

Contents primary and by-products of POL was defined by I.A. Volchegorsky's method [Volchegorsky, et. al., 1989]. In saliva defined antioxidant enzymes a catalase and to superoxide dismutase (SOD) and also products of perokisny oxidation of lipids: Geptan1 (E232/E220), Geptan2 (E278/E220), Izopropanol1 (E232/E220), Izopropanol2 (E278/E220).

The lipidic fraction of samples from 0.5 ml was extracted in 5 ml of mix of equal volumes of heptane and isopropanol when stirring within 15 minutes. Lipidic extract was separated centrifugation, diluted 5 ml of mix heptane-isopropanol (3:7 on volume) and divided into phases addition 2 ml of water solution of hydrochloric acid (pH =2). In 30 minutes the heptanew (top) phase was transferred to a separate test tube, and added 1 grams of dry chloride sodium for office of a water phase to aqueous-alcoholic (lower). After that stirred up again within 5 minutes. In 20 minutes selected the received extracts and their fotometriroval with various lengths of waves of ultra-violet range. At the same time, the heptanew phase focuses the most part of neutral lipids (triglycerides) while the isopropanol phase contains polar or structural lipids (phospholipids). The assessment of maintenance of primary products of a lipidic peroksidation was carried out on the relation of optical density of the extracts measured at 232 and 220 nanometers – they were characterized by size E232/E220. The maintenance of by-products the POL was characterized by similar size E278/E220 [Segal, 2004].

Activity Superoxide Dismutases

Superoxide dismutases determined activity by S. Chevri's method, etc. (1985). On the basis of measurement of speed of reaction of restoration a nitrotetrazoliya blue (HTC) in the presence of NADN and phenazine metasulfate at non-enzymatic formation of a superoxidic radical [Chevari, Chiba & Seky, 1985].

Activities of a Catalase

Determination of activity of a catalase was carried out by N.S. Mamontov's (1994) method based on hydrogen peroxide decomposition reaction by a catalase and definition of light absorption of a complex of peroxide of hydrogen with ammonium molybdate at $\lambda = 410$ nanometers. 25 microlitre of the gomogenat of saliva mixed 0.03% of peroxide of hydrogen from 2 ml. The stop of reaction was carried out by addition of 2 ml of 2% of solution of molybdate of ammonium in 10 min. Check experiment without enzyme was in parallel made. A difference in optical density of control and skilled tests were used for calculation of activity of enzyme taking into account molar coefficient of absorption of complex $22,2 \times 10^3 \text{ cm}^{-1} \text{ M}^{-1}$ [Mamontova, Beloborodova & Tyukalova, 1994].

Statistical Analysis

Results of the conducted examinations it was carried out by method of variation statistics of t-criterion Styudenta. Data were expressed as arithmetic-mean (M) and its standard mistake ($\pm m$). About reliability of distinctions of average sizes judged by Styudent's (t) criterion. When probability has to range $0.05 < P < 0.25$, in addition applied criterion of nonparametric statistics of Mann-Whitney (U).

Results

Dynamics of indicators of a biochemical research of saliva which analysis characterizes functioning of antioxidant factors of a nonspecific system of adaptation and indicators of perokisny oxidation of lipids in an organism of young sprinters is presented in table 1. During the year period of occupations track and field athletics contents primary the heptanrastvorimyk of products of perokisny oxidation of lipids in saliva of sportswomen was authentically above, than at the girls who are not playing sports. This fact demonstrates increase in intensity of oxidizing processes at teenagers who are engaged in track and field athletics sprint. The tendency to increase in contents primary the heptanrastvorimyk of lipoperoksid at young athletes was revealed at competitive stages of training process. Contents primary the heptanrastvorimyk of products of perokisny oxidation of lipids at young sprinters at a winter competitive stage of training process was authentically 11.5% higher ($p<0.001$) and respectively for 10.9% ($p<0.001$) during the summer competitive period, in comparison with control.

Contents secondary heptane-soluble products of perokisny oxidation of lipids in saliva of sportswomen on the termination of competitive stages of training process had reliable distinctions in comparison with the girls who are not playing sports. So, contents secondary the heptane-soluble of products of perokisny oxidation of lipids at young sprinters at winter and summer competitive stages of training process was 14% higher ($p<0.001$) and for 17.4% ($p<0.001$) respectively in comparison with control.

Table 1. Results of the biochemical analysis of saliva of young sportswomen ($M\pm m$)

Indicator of the bikhimicheskyy analysis	SN n=20	SS n=20	SN n=20	SS n=20
Products POL Heptane-1	0,179 $\pm$ 0,0038 102,9%	0,194 $\pm$ 0,0044 111,5%***	0,183 $\pm$ 0,004 105,2%	0,193 $\pm$ 0,0042 110,9%***
Products POL Heptane-2	0,129 $\pm$ 0,0033 103,3%	0,138 $\pm$ 0,004 114%***	0,127 $\pm$ 0,0032 105%	0,145 $\pm$ 0,0046 117,4%***
Products POL Isopropanol-1	0,501 $\pm$ 0,0098 101,2%	0,538 $\pm$ 0,017 108,7%*	0,510 $\pm$ 0,0099 103%	0,544 $\pm$ 0,019 110%**
Products POL Isopropanol-2	0,315 $\pm$ 0,0062 98,4%	0,365 $\pm$ 0,0091 114,1%***	0,325 $\pm$ 0,0068 101,6%	0,377 $\pm$ 0,014 117,8%***
Superoxide dismutase (a.u./mg)	0,693 $\pm$ 0,016 98,9%	0,783 $\pm$ 0,029 111,7%**	0,707 $\pm$ 0,02 100,9%	0,791 $\pm$ 0,031 112,8%**
Catalase (nmol/mg min.)	134,20 $\pm$ 3,68 96,7%	163,21 $\pm$ 4,99 117,6%***	136,43 $\pm$ 3,79 98,3%	165,48 $\pm$ 5,19 119,2%***

Note: SN – the teenagers who are not playing sports; SS – young sprinters;
reliability of differences from the corresponding control * – $p\leq 0,05$; ** – $p\leq 0,01$; *** – $p\leq 0,001$, calculated by means of Styudent's criterion (t).

It is known that biodestructive effects of perokisny oxidation of lipids are implemented only at considerable excess of concentration of lipoperoksid over the level of physiological norm. Therefore moderate increase in level of any category of these metabolites is not symptom of pathology yet, and this fact is sign of activation of all system of perokisny oxidation of lipids, and not just the system producing lipoperokis [Dubina, 2001].

Comparison of the key biochemical indicators of saliva of young sprinters with indicators of the teenagers of similar age who are not playing sports shows that contents primary the izopropanolrastvorimyk of products the POL of young sprinters at winter and summer competitive stages of training process authentically increased by 8.7% ($p<0.05$) and for 10% ($p<0.01$) respectively in comparison with control. Contents secondary the izopropanolrastvorimyk of products the FLOOR in saliva of athletes at winter and summer competitive stages of training process was authentic 14% above ($p<0.001$) and for 17.8% ($p<0.001$) respectively in comparison with control [Kislyakova, Saraykin & Pavlova, 2012].

Thus, the most expressed was increase in level secondary the izopropanolrastvorimyk of products of perokisny oxidation of lipids. This fact demonstrates activation of an antioxidant system under the influence of systematic physical activities. The differences in contents established by us secondary the izopropanolrastvorimyk of products of perokisny oxidation of lipids at the young sprinters and teenagers who are not doing athletics can have a direct bearing on restructurings of membranes of cages at physical activities. Comparing indicators of antioxidant enzymes of young sprinters to indicators of the children of the same age who are not playing sports we revealed that at young athletes the maintenance of a catalase is differentiated and has distinctions on the termination of competitive stages of training process. So, the activity of a catalase at young sprinters at winter and summer competitive stages of training process was authentically 17.6% higher ($p<0.001$) and for 19.2% ($p<0.001$) respectively in comparison with control. The similar trend was revealed at competitive stages of training process. The maintenance of a superoksiddismuktaza at young sprinters at a winter

competitive stage of training process was authentically 11.7% higher ($p<0.01$) and respectively for 12.8% ($p<0.01$) during the summer competitive period, in comparison with control. However the activity of a superoksiddismuktaza at sportswomen was in stable values in dynamics of training process. It says about normal course of physiological processes in an organism of athletes without violation of adaptable mechanisms [Saraykin, Kislyakova & Pavlova, 2012].

Data of a biochemical research of saliva of jumpers before and after a training load are provided in table 2. The analysis of these changes shows accumulation of products the POL and antioxidant enzymes in saliva of athletes what to be a prerequisite to justification of nature of adaptive changes in an organism of athletes under the influence of a training load.

Table 2. Results of the biochemical analysis of saliva of athletes before and after a training load ($M\pm m$)

Indicator of the bikhimicheskyy analysis	Before loading (n=5)	After loading (n=5)
Products POL Heptane-1	0,197 $\pm$ 0,013 100%	0,212 $\pm$ 0,009 107,6%
Products POL Heptane-2	0,198 $\pm$ 0,008 100%	0,182 $\pm$ 0,009* 91,9%
Products POL Isopropanol-1	0,132 $\pm$ 0,009 100%	0,128 $\pm$ 0,031 96,9%
Products POL Isopropanol-2	0,0145 $\pm$ 0,003 100%	0,0141 $\pm$ 0,061 97,2%
Superoxide dismutase (a.u./mg)	150,85 $\pm$ 11,52 100%	193,93 $\pm$ 12,72*** 128,6%
Catalase (nmol/mg min.)	0,766 $\pm$ 0,037 100%	0,822 $\pm$ 0,058 107,3%

Note: * – $p\leq 0.05$; *** – $p\leq 0.001$ – reliability of differences in group athletes after loading on sravneniy with the same group to loading.

Enzymes a catalase and superoxide dismutase belong to metabolites a stress - the limiting systems of an organism which become more active at emergence any stress reaction in response to physical activity. Therefore reliable increase in indicators a stress - the limiting metabolites can serve as the real fact of improvement of functioning of a system of antioxidant protection. Therefore, it will be possible to speak about positive dynamics of adaptive changes in an organism of athletes under the influence of training loads [Kamskova, Segal & Saraykin, 2012].

Primary geptanrastvorimy and also primary and secondary izopropanolrastvorimy products the POL authentically did not change that the POL as power sources for muscle work demonstrates more economic reaction of an organism to stress physical activity and good utilization of products. In figure 1 dynamics of change of indicators secondary the geptanrastvorimykh of products the POL in saliva of athletes before and after loading is represented. Follows from data of figure 1 that after a training load the maintenance of products the POL, soluble in heptane-1, authentically decreased by 8.1% ($p<0.05$).

Fig. 1 – Indicators secondary geptanrastvorimykh of products POL before and after loading in saliva of athletes

Note: * – $p<0.05$ – reliability of distinctions in relation to indicators to loading.

It demonstrates not only profitability in reaction of an organism in response to physical activity, but also good utilization of products the POL as power sources for muscle work and also indirectly characterizes functioning of antioxidant systems of nonspecific protection of an organism against a stress.

In figure 2 dynamics of activity of antioxidant enzyme of a catalase in saliva of athletes before and after loading is presented. The activity of a catalase to loading was 150.85 ± 11.52 nmol/mg. mines, after a training load the activity of a catalase authentically changed and was 193.93 ± 12.72 nmol/mg. mines, i.e. increased by 28.6% ($p < 0.05$) that testifies to the considerable power of antioxidant systems of nonspecific protection of an organism of athletes from the stressor of damages who were called by large volumes and intensity of physical activity at high-class masters.

Fig. 2 – To flight of activity of an antioxidant catalase of enzyme in saliva of athletes before and after loading

Note: * – $p < 0.001$ – reliability of distinctions in relation to indicators to loading.

The activity of enzyme superoxide dismutases authentically did not change, having only slightly increased that can also demonstrate inclusion of antioxidant systems of nonspecific protection in response to a physical training load. It says about normal course of physiological processes in an organism of athletes. At application big on the volume and intensity of physical activities there is no failure of adaptation opportunities of an organism of athletes.

Discussion

Results of a research primary and secondary the geptanrastvorimyk of lipoperoksid in saliva of sprinters of 14-16 years in a year cycle of training process revealed specific changes in the system of perekisny oxidation of lipids. Dynamics of maintenance secondary the geptanrastvorimyk of lipoperoksid was similar to the nature of changes of level of primary products of perekisny oxidation of lipids.

Indicators of antioxidant enzymes of a catalase and superoxide dismutases it is reliable above, in comparison with persons, not playing sports that speaks about growth of power of antioxidant factors of nonspecific protection of an organism of the teenagers doing athletics from the stressor of damages by physical activity. Therefore, educational and training process of mastering track and field athletics provides adaptation of an antioxidant system of young sprinters to physical activity. It is a consequence of activation of oxidation-reduction processes, the amplifying oxygen exchange, effective utilization the nedookislennykh of substrates and their mobilization in oxidizing processes that leads to high intensity of oxidation-reduction reactions, to activity of the anabolic exchange maintaining high efficiency of enzymatic antioxidant protection. As the heptan phase of lipidic extracts contains mainly neutral fats, it is possible to assume that reliable decrease secondary the geptanrastvorimyk of lipoperoksid are connected with increase of extent of mobilization, as a power source of substrates of reoxidation – the free fatty acids which are a part of the circulating triglycerides [Tolkachyova, Levachev & Kulakova, 1992; Suzdal'skiy, Menshikov & Modera, 2000]. The fact of decrease in level found by us the izopropanolrastvorimyk of lipoperoksid at athletes after stress high-intensity load, perhaps, is feature of adaptation process and is connected with restructuring of membranes of the cages containing mainly of phospholipids [Kim, et al., 1996]. Besides, increase in activity of antioxidant enzyme of a catalase, in turn constrain increase in products the FLOOR. In literature there are data that the activity of antioxidant enzymes depends on intensity of loading [Powers & Lennon, 1999].

Conclusions

In a macrocycle of training process with increase in physical activity activation of perekisny oxidation of lipids with change of ratios of by-products of a peroksidation was observed. The maximum increase in maintenance of ketodienes and the interfaced triyen soluble in heptane-2 and isopropanol-2, was noted in saliva during the summer competitive period respectively for 17.4% and 17.8% ($p < 0.001$) in comparison with control. Such activation of perekisny oxidation of lipids demonstrates increase in a stressful component in the competitive period at young athletes.

In a summer training annual macrocycle at adaptation of sportswomen to physical activity antioxidant enzymes in saliva (superoxide dismutase and a catalase) authentically increased in the competitive period

respectively by 12.8% ($p < 0.01$) and 19.2% ($p < 0.001$) in comparison with control. Such change is connected with protection of an organism against radicals of peroxidation of lipids.

At application of progressive loadings for jumpers a triple jump observed changes in the following physiological systems of an organism: indicators of a biochemical research of saliva positively changed for 18%.

At adaptation at athletes to surplus loads the power of antioxidant systems increases that is expressed in reliable increase in activity of a catalase (for 28.6%) and a tendency to increase in activity of SOD.

At adaptation of athletes to surplus loads there is a reliable reduction of contents heptane - soluble products (for 9.1%) to an exit of the neutral lipids and increase in power power providing functional systems. Thus, need of application a stress of loadings during the annual period of preparation for the purpose of increase in level of competitive preparation physiologically is proved.

Conflicts of interest

The authors declared no potential conflicts of interest with respect to the research, authorship and publication of this article.

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