

Assessment of arm wrestlers' adaptation status on the base of saliva biochemical characteristics in dynamic of competition and training loads

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Abstract:

Analysis of arm wrestlers' biochemical characteristics permits to assess potential of adaptation reactions. Saliva is the most eligible object for testing. It can give indicators of pro-oxidant – anti-oxidant balance, energy metabolism and endocrine homeostasis. *The purpose of the research:* is studying of changes in arm wrestlers' saliva biochemical indicators under influence of competition and training loads. *Material and methods:* in the research sportsmen (age – 22.13±3. years) participated. The sportsmen were divided into two groups; 13 sportsmen in each. Group 1 was tested in dynamic of competition loads. Group 2 was tested in dynamic of trainings loads. We used methodic for determination concentration of lipids per-oxidation (LP), anti-oxidant system's (AOS) condition, levels of lactic acid, pyruvic acid, pH, cortisol and thyroxine. *Results:* in dynamic of competitions we found correspondence of competition loads to functional potentials for elite sportsmen. In sportsmen of lower qualification we found tension of LP – AOS system, sharp increase of lactic acid, Ph shift to acid side. The offered by us indices permitted to confirm stable adaptive status of elite sportsmen. Analysis of correlation matrixes confirmed feasibility of loads and the fact that for their overcoming own adaptation reserves were quite sufficient. Changes under influence of training loads were the more expressive: we registered activation of LP – AOS, compensator increase of AOS activity, glycolysis intensification and activation of pituitary – hypophysial adrenocortical system. *Conclusions:* we have confirmed adequacy of bio-chemical methodic application for arm wrestlers. Bio chemical criteria illustrate different degree of stability and adaptation potentials' capacity depending on sportsmanship. We also have confirmed information significance of indices, which reflect correlation of different biochemical indicators and dynamic of different correlation structures.

Key words: arm wrestling, bio chemical indicators, adaptation, trainings loads, competitions.

Introduction

Assessment of sportsman's fitness and determination of training's dynamic with the help of objective methods, including bio-chemical ones, are compulsory conditions of training process's management. Results and effectiveness of training depend to large extent on loads correspondence to functional potentials, workability level and organism's fitness (Shaposhnikova, 1984; Ivashchenko, Yermakova, et al., 2015).

Mio-chemical control plays important role in rising of sport workability, reducing of fatigue (Ajrapetianc, Godik, 1991; Paczuski, Cieślicka, 2013). Bio-chemical testing permits to judge about characteristics of loads, adequacy and effectiveness of training loads (Skvorcov, 1990; Mohammad Ali Azarbayjani, et al., 2010). Changes in biological liquids under influence of training loads depend on level and period of training. With it equal loads can cause different changes of metabolism (Uil'iams, 1997). On the base of analysis of bio-chemical reactions' peculiarities we made conclusion about their influence on football players' physical qualities and endurance (Hammouda, Chtourou et al., 2013). Changeability of bio-chemical parameters of team kinds of sports' players is considered to be one of factors, influencing on efficiency (Biersner, McHugh, et al., 1981; Lindsay, Lewis, et al., 2015). Researches of other authors affirm that results of biochemical testing of aerobic ability are valuable for prognostication of sport success (Pivarnik, Fulton, et al., 1993).

Considering specificity of sampling and epidemiological safety, saliva is a promising and informative object of testing. Analysis of its bio-chemical indicators under influence of physical loads is a simple and highly informative assessment method of sportsmen's functional status (Sokolova, Martiukhina, 1999; Hough, et al., 2013; Hayes, Sculthorpe, et al., 2015). Analysis of sportsmen saliva's bio-chemical indicators permits to assess purposefulness of these data as additional criterion of physical qualities' development (Martiukhina, 1998) and increasing of workability (Bortolini, Agostini, et al., 2009; Mohammad, Mohammad, et al., 2012; Coad, Mcllellan, et al., 2015).

Sportsmen's intensive physical loads often result in over-tension of muscular system (Levandovskaya, & Prusik, 2014; Ivashchenko, Khudolii, et al., 2015), muscular hypoxia (Gorelov, Obvintsev, et al., 2014) and

creation of excessive free radicals (Blinova, Troshin, et al., 2013; Asghar, Ameghani, et al., 2014; Mehranpour, Silalerdetkul, et al., 2015). With insufficient system of antioxidant protection (AOS) their impact on membranes can result in disorders of sportsman's organism, decrease of his workability and efficiency. In his connection it is very important to assess mobile balance in system LP-AOS. LP intensity reflects level of oxidation stress in organism, permits to prognosticate progressing of pre-nosological health disorders and probability of their transformations in pathologies. AOS capacity reflects organism's protection. In our context this protection is regarded as indicator of sportsmen's fitness for highest achievements against the background of health optimum preservation.

In our previous works we proved importance of studying of arm wrestlers' morphological and functional characteristics, as factors, determining success (Podrigalo, Galashko, et al., 2014; Podrigalo, Iermakov, et al., 2015; Podrigalo, Istomin, et al., 2010). Studying of these indicators shall be supplemented by researching of adaptation potential's capacity. For this it would be purposeful to apply bio-chemical methods. Some authors say about demand in supplement of functional tests by bio-chemical ones (George, Fellingham, et al., 1998; Ruslanov, Prusik, et al., 2011; Evdokimov, 2011). As per the data of other authors bio-chemical tests permit to compare and analyze efficiency of different sport exercises (Mahler, Andrea, et al., 1987; Kovalenko, Nechyporenko, 2014; Saeed, Mirza, et al., 2014; Rovniy, Lastochkin, 2015), arm wrestling inclusive (Voronkov, Nikulin, et al., 2014). Besides, with bio-chemical tests distinctions in physical condition can be revealed (Chernozub, 2011; Bekris, Giovanis, et al., 2011; Perroni, Cignitti, et al., 2014), as well as in coordination (Glozhik, Iavdoshik, 2011) and anaerobic energy supply systems (Adashevskiy, Iermakov, et al., 2012; Serorez, Navka, 2014; Sybil, Pervachuk, et al., 2015). It significantly increases their diagnostic and prognostic value.

However, up to the present time peculiarities of arm wrestlers' AOS protection, energy supply systems have not been studied sufficiently yet as well as their dynamic in different raining periods.

Basing on the above said **the purpose of this work** became assessment of arm wrestlers' adaptation status in dynamic of competition and training loads on the base of bio-chemical analysis of saliva.

Material and methods

Participants: our research covered 26 sportsmen of age (22.13±3.24) years, divided in two equal groups. 1st group sportsmen were tested in dynamic of competition loads. 2nd group sportsmen were tested in dynamic of training loads. Depending on sportsmanship 1st group was divided in two subgroups: 1a – experienced sportsmen (n=6, mean age 25.65±2.47 years). Subgroup 1b consisted of sportsmen – beginners (n=7, mean age 18.61±2.57 years). Group 2 was not divided into subgroups. It consisted of sportsmen, who, mainly, had mass degrees.

Organization of the research implied collection of saliva and its testing before and after trainings. After mouth rinsing with clean water, sportsmen collected saliva in clean glass tubes. For analyzing of LP we studied content of saliva. As intermittent products we registered concentration of diene conjugates (DC) (Gavrilov, Mikorudnaia, 1983; Li, & Gleeson, 2005; Le Panse, Vibarel-Rebot, et al., 2010). As final product we registered concentration of malonic dialdehyde (MA) (Fedorova, Korshunova, et al., 2014; Papacosta, Nassis, et al., 2015; Edwards, & Casto, 2015). AOS was assessed by activity of catalase (Chevari, Shtringer, 1991; Mohammad, Azarbayjani, et al., 2010), concentration of SH-groups (Torchinskij, 1971; Walsh, 1999; Taylor, Turner, et al., 2015) and reduced glutathione (Severin, Solov'eva, 1989; Coad, Gray, et al., 2015; Crewther, Hamilton, et al., 2015). In our research concentration of lactic (LA) and pyruvic (PA) acids we considered as indicators of energetic condition with the help of kit of reagents of "Labsystems" (Finland) production. For assessment of acid alkaline balance we registered pH of saliva. Thyroxine and cortisol levels were determined for assessment of endocrine system's response to physical loads with the help of reagents, produced by Institute BOH AS of Belarus. For increasing of information potential of the received data we calculated indices, characterizing organism's AO protection (DC/ activity of catalase, DC/ reduced glutathione) and energy supply (LA/PA).

Statistical analysis of the received data was conducted with the help of licensed Excel programs. We determined indicators of descriptive statistic (mean arithmetic, standard deviation and error of mean value). Confidence of mean values' differences was assessed by Student's criterion and by sign criterion. Difference was considered as confident with $p < 0.05$. For determination of indicators' correlation we calculated correlation coefficients by Pearson and constructed correlation matrixes (Antomonov, 2006; Khudolii, Iermakov, Prusik, 2015; Zaporozhanov, Borachinski, et al., 2015; Khudolii, Iermakov, Ananchenko, 2015). Comparative analysis of correlation matrixes was fulfilled with the help of the following indicators: specific weight of confident connections, coefficient of labilizing/synchronization (CL), mean correlation coefficient (MCC). The two latter indicators were determined by special formula (Zosimov, 2000):

$$CL = [n / N(N-1)] \times 100\% \quad (1)$$

Where,

n – the sum of all significant correlations, formed by every parameter of correlation structure;

N – total quantity of structure parameters.

$$MCC = \sum r_j / n \quad (2)$$

Where,

Σr_j –the sum of all confident correlation coefficients of the structure;

n – quantity of significant correlations.

Results of the researches

Results of the researches are given in table 1.

Table 1. Bio chemical indicators of arm wrestlers' saliva in process of competitions

Indicator	Before competitions			After competitions		
	1group (n=13)	1a group (n=6)	1b group (n=7)	1 group (n=13)	1a group (n=6)	1b group (n=7)
Malonic dialdehyde, $\mu\text{mol/l}$	4,80±1,09	6,86±1,96	3,08±0,69	5,90±0,81	4,77±1,03	6,85±1,14 ¹
Diene conjugates, $\mu\text{mol/l}$	33,96±3,29	41,26±4,78**	27,88±2,87	34,45±3,32	29,55±3,21*	38,54±3,50*
Activity of catalase, $\mu\text{catal/l}$	3,38±0,40	4,28±0,57**	2,63±0,35	4,62±0,32*	4,19±0,39	4,98±0,47*
Reduced glutathione, mmol/l	2,98±0,39	3,18±0,66	2,82±0,51	3,53±0,34	3,64±0,57	3,45±0,45
SH-groups, mmol/l	1,74±0,34	2,26±0,59	1,31±0,34	1,82±0,24	1,68±0,47	1,93±0,23
Lactic acid, mmol/l	1,32±0,35	2,04±0,62**	0,72±0,21	2,00±0,31	1,92±0,61	2,06±0,32*
Pyruvic acid, $\mu\text{mol/l}$	28,72±4,37	34,59±6,57	23,83±5,54	33,74±3,37	29,98±6,17	36,88±4,73
pH of saliva	6,48±0,25	6,08±0,29	6,82±0,34	6,02±0,18	6,14±0,28	5,92±0,24*
DC/catalase activity	10,85±1,00	9,89±0,75	11,65±1,74	7,45±0,28*	7,01±0,33*	7,84±0,38*
DC/reduced glutathione	12,41±1,22	14,64±2,10	10,55±1,02	10,25±0,80	2,67±1,19**	11,60±0,78
LA/PA	0,04±0,01	0,020±0,010**	0,030±0,003	0,06±0,01	0,02±0,01	0,06±0,01*

* - differences in dynamic of competitions are confident ($p < 0.05$);

** - difference in case of less experienced sportsmen are confident ($p < 0.05$);

catal - mol/s.

The received data does not permit to speak about expressed changes in sportsmen's bio-chemical status. For example, concentration of LP products did not change confidently. Activation of AOS is witnessed only by increase of catalase activity.

The absence of significant changes in LA and PA, saliva pH can be interpreted as reflection of blood buffer systems' insignificant tension and absence of glycolysis intensification. At the same time index of DC correlation and catalase activity confidently reduced. It shall be assessed as change of balance in system LP-AOS at the account of activation of protection mechanisms.

Considering different sportsmanship level of the tested it was interesting to observe dynamic of bio chemical parameters depending on this criterion. The given above data prove correspondence of competition load to functional potentials in subgroup 1a. It is confirmed by absence of confidence differences between initial and final parameters. By concentration of DC and index DC/catalase activity we noticed expressed reduction after competitions ($p < 0.05$). At the same time sportsmen of mass degrees demonstrated confident increase of LP products' concentration and increase of catalase activity nearly 2 times. At the same time we observed sharp increase of LA concentration and expressed shift of saliva pH to acid side. These changes are characteristic for metabolic acidosis, which results from high nervous-muscular tension. Thus, in this subgroup bio chemical changes reflect influence of oxidation stress.

Comparison of subgroups also illustrates elite sportsmen's more stable adaptive condition. It is proved by initially higher catalase activity, less LA/PA index before competitions. It permits to affirm that they have higher adaptation level. Confidently less value of DC/reduced glutathione after competitions points at the fact that group 1 undergoes competition loads better at the account of optimization of status.

Analysis of individual data showed that the tested sportsmen are characterized by different types of responding to load. In subgroup 1a in all the tested we registered reduction of MA and DC levels (accordingly 2.09 ± 1.10 micromole/l and 11.71 ± 4.49 micromole/l). In subgroup 1b level of LP products increased. Dynamic of MA was 3.77 ± 1.26 micromole/l; change of DC was 10.66 ± 4.12 micromole/l. The found distinctions between subgroups were confident ($p < 0.05$). AS changes were stable in subgroup 1a and coefficient lactate/pyruvate does not practically change. In less experienced sportsmen there was prevalence of the following: increased concentration of reduced glutathione; SH-group and catalase activity; correlation LA/PA increased 2 times.

Results of bio-chemical testing for training loads are given in table 2.

Table 2. Bio chemical indicators of arm wrestlers' saliva in process of trainings

Indicator	Before competitions	After competitions
Malonic dialdehyde, $\mu\text{mol/l}$	3,12 \pm 0,35	8,18 \pm 1,60*
Diene conjugates, $\mu\text{mol/l}$	28,38 \pm 1,11	83,33 \pm 9,69*
Activity of catalase, $\mu\text{catal/l}$	1,78 \pm 0,21	3,91 \pm 0,51*
Reduced glutathione, $\mu\text{mol/l}$	1,39 \pm 0,20	3,10 \pm 0,35*
SH-groups, $\mu\text{mol/l}$	1,05 \pm 0,14	2,36 \pm 0,39*
Lactic acid, $\mu\text{mol/l}$	0,63 \pm 0,03	2,02 \pm 0,17*
Pyruvic acid, $\mu\text{mol/l}$	19,90 \pm 0,50	48,63 \pm 3,13*
pH of saliva	6,33 \pm 0,23	5,75 \pm 0,20
Thyroxine, nmol/l	52,96 \pm 3,29	59,09 \pm 3,13
Cortisol, nmol/l	184,54 \pm 11,32	390,15 \pm 30,45*
DC/catalase activity	18,82 \pm 2,50	24,76 \pm 3,44
DC/ reduced glutathione	1,58 \pm 0,27	1,74 \pm 0,36
LA/PA	0,030 \pm 0,003	0,040 \pm 0,004*

Notes: * - distinctions are confident ($p < 0.05$); catal - mol/s.

Results of testing of bio-chemical reactions to loads reflect more expressed dynamic comparing with competition period. May be it is connected with the fact that physical load at training is more than at competitions. Confident ($p < 0.05$) increase of LP – DC and MA products, increase of AOS activity at the account of all studied indicators, were proved. Shift of saliva pH, though not being confident, reflects tendency to progressing of acidosis. Significant increase of lactate and pyruvic acids also was proved. Against the background of stable thyroxine content we registered expressed increase of cortisol concentration. Application of non parametric indicator (sign criterion) confirmed that index DC/catalase activity significantly increased ($p < 0.05$). Such dynamic was registered in 11 from 13 tested sportsmen. Besides, we confirmed increase of index lactate/pyruvate in dynamic of training.

Discussion

From bio-chemical point of view arm wrestling is characterized by anaerobic work at maximal power, duration of which does not exceed 10-20 sec. This work is usually fulfilled using inter-cellular reserves of creatinephosphate and ATP. Oxygen debt is not large; it has a-lactate character and must cover re-synthesis of the used macro-ergs. There is no significant accumulation of lactate. Involvement of glycolysis in ensuring of such short-term loads is possible. In this case lactate's content a little increases in working muscles. In this kind of sports endurance depends on reserves of creatine-phosphate in working organs, efficiency of its usage in work and stability of a-lactate anaerobic system's enzymes (ATPase and creatine kinase) in conditions of accumulation of anaerobic collapse products.

Results, given in table 1, permit to assume that competition load of sportsmen is not excessive. Capacity of adaptation – compensatory mechanisms is sufficient to resist to oxidation stress. This assumption can be proved by confident reduction of index DC/catalase activity. It reflects just level of system's readiness to resist unfavorable impact of oxidation stress and is an important prognostic indicator. May be the absence of significant changes is connected with initially increased concentration of LP products, which results from progressing of stress of waiting for competition loads.

Absence of significant changes of LA and PA, saliva pH is conditioned by specificity of arm wrestling, where duels take several seconds and can not cause deep disorders of oxidation phosphating. Validity of this assumption is confirmed by analysis of correlation structures, which was earlier used for assessment of arm wrestlers' condition (Podrigalo et. al., 2015). Before competitions there were: 28 confident correlations (100%); synchronization indicator was 38.98; mean system's correlation was 0,78. After competitions quantity of correlations reduced to 24 (85.71%); synchronization indicator decreased to 31.26; mean system's correlation – to 0.73. From positions of pre-nosological diagnostic it can be interpreted as result of loads' feasibility, for overcoming of which organism needs only its own adaptation reserves.

Table 2 data reflect stability of adaptation processes of elite sportsmen as well as formation of adaptation trace, which is analogous to the described in work by Meerson and Pshennikova (1988). Changes in less experienced sportsmen shall be understood as tension of LP-AOS system and its passing to new level of functioning.

Analysis of individual results permits to conclude that in subgroup 1a work is fulfilled only at the account of endogenous reserves of highly energetic compounds. In less experienced sportsmen energetic supply of muscular functioning is ensured also by glycolysis. That is, analysis of bio-chemical indicators proves again that sportsmen of subgroup 1a are more successful in arm wrestling and are characterized by ability to demonstrate larger strength in conditions of short-term duel.

Table 2 data illustrate the following: LP activation under load; compensatory increase of AOS activity as well as increase of LA and PA concentration and correlation between them, which reflects intensification of

glycolysis processes. It is interesting that saliva pH did not confidently change. It witnesses about adequacy of training load and its correspondence to functional potentials.

Change of cortisol level and absence of changes in thyroxine concentration can be interpreted as adequacy of trained persons' response to physical load at the account of activation of pituitary-adrenocortical system.

The available in literature results of sportsmen's bio-chemical characteristics' assessments confirm our conclusions. For example, Svat'ev, & Gostishchev (2010) and Blinova, et. al. (2013) studied dynamic of bio-chemical indicators in training and competition periods of academic rowers. They confirmed that in nearly half of sportsmen there took place reduction of AOS protection against free radicals. With it general AOS ability of serum weakens as well as its separate components: catalase, ceruloplasmin, vitamin E. This weakening results in increase of MA concentration in blood, concentration of peroxides, metabolites of nitric oxide. All these condition strong toxic impact on cells.

Davies, et. al. (1982) note that under intensive physical loads intensification of oxidant formation results in shift in balance of pro- and AOS compounds, which work in skeletal muscles. Besides, oxidation stress starts progressing – this phenomenon is supposed to be the basis of muscular fatigue and muscles' dysfunctions.

Results, obtained by Ji (1999) witness that durable and regular physical trainings lead to increase of basic activity of one AOS enzymes and weakening of other.

On example of elite rugby players Thivel, Maso, et al. (2015) confirmed impact of eating on LP – AOS. It permits to significantly soften unfavorable effects of large physical loads.

Thus, the received results deepen the available information about characteristics of arm wrestlers' adaptation status, about significance of bio-chemical testing for prognostication of successfulness. The applied methodic of data processing and analysis permit to more accurately differentiate status of sportsmen of different skillfulness.

Conclusions

Thus, research of sportsmen's responding to competition and training loads confirmed adequacy of application, in this case, of bio chemical methodic. The registered distinctions in responses to different loads are conditioned by their different expressiveness and degree of adaptation mechanisms' tension. Bio-chemical criteria of different skillfulness sportsmen illustrate different degree of stability and capacity of adaptation potentials. The received results witness that with selection in this kind of sports it would be purposeful to determine coefficients LP/AOS, lactate/pyruvate in tests for loads.

The assessment data of LP and AOS processes and degree of balance shift between pro-oxidants and anti-oxidants in biological substrates can be regarded as objective and very sensitive indicators of organism's general condition, activity and perfectness of regulation systems' functioning, of maintaining homeostasis balance.

We have confirmed information significance of indices, reflecting correlation of different bio-chemical indicators. Information significance of indices is also important for the following: analysis of correlation structures' dynamic when selecting the most promising sportsmen; assessment of adequacy of the used loads; prevention from possible health disorders. Painlessness and informative potential of saliva testing are the reasons of application of such testing in monitoring of sportsmen's functional status.

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