

Dynamics of characteristics of lipids and antioxidant system peroxidation of the phosphorus plant workers blood depending on individual sensitivity to yellow phosphorus under the influence of liquorice herbal pharmaceutical product

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Abstract: Research has been carried out at occupational pathology department of South-Kazakhstan branch of scientific centre of occupational hygiene and occupational diseases at No.2 clinic of Taraz city. Seventy-two probationary male employees of basic occupations with 5-10 years of employment length from Dzhambyl phosphorous plant and 148 phosphorous intoxicated people have been examined. Biochemical research techniques have been applied. Administration of bioslastiline by workers depending on sensitivity to yellow phosphorus showed, that the most efficient and effective impact is appeared during 10 days of administration by “resistant” workers, 14 days – by “sensitive” and 20 days – by “very sensitive” workers. It is proved by reduction of results of indicated coefficient of lipid peroxidation of antioxidant blood system.

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1. Introduction

Occupational pathology resulted from production of yellow phosphorus (YP) is chronic intoxication by phosphorus compounds (CIPC) and its non-organic compounds (Dauletbekova et al, 1991).

In recent years, multiple organ failure within CIPC caused the interest in researching the lipid peroxidation (LPO). Activation of peroxide lipids oxidation (PLO) and suppression of antioxidant system ferments (ASF) of rats, which is worsen in case of unbalanced diet, is proved in CIPC pathogenesis with the help of experiment on the basis of phosphorus intoxication model (Kulkybayev, 1992). It has been defined, based on the large amount of phosphorus plant workers and CIPC diseased people examination, that the key mechanism in CIPC pathogenesis is activation of PLO processes, which leads to failure of body's ASF (Kudabayev, 1999).

Phosphorus is one of the general protoplasmatic poisons, which causes involvement of heart, liver, kidneys (Brent et al, 2005).

Potential symptoms of chronic intoxication by yellow phosphorus such as cachexia, anaemia, bronchitis, general weakness and phoshy jaw have been noted after inhalation or ingestion (2001). The most important sign of phosphorus chronic intoxication is osteomyelitis of mandible: more often, this is lower jaw and rarely is the upper jaw, which defines like dental abnormalities in the beginning

(1983).

N. Ormanov (Ormanov, 1990) and D. Adilbekova (Adilbekova and Ormanov, 1989) have studied early, intermediate and end products of PLO and defined increasing of PLO processes of the people with long-term employment length at furnace plants and of CIPC diseased people. Therefore, information considering importance of PLO role in CIPC pathogenesis has been obtained to prove the results of experimental research.

CIPC is developing after 3-5 years in case of high phosphorus concentration, which exceeds maximum allowable concentrations in several times. The first symptoms can appear in 8-12 years in case of relatively small pollution of air by phosphorus compounds (Dauletbakova et al, 1991). Almost all body systems and organs are involved into pathologic process (Strelyukhina, 1982).

N. Ormanov and other authors (Pernebekova et al, 2013) have studied treatment modalities problems within heart intoxication by phosphorus and isadrine compounds. Also N. Ormanov and D. Adilbekova (Ormanov and Adilbekova, 2011) have studied oxidative homeostasis and phosphorus pathology.

M. Dauletbakova, N. Ormanov and M. Berdykhodzhin (Dauletbakova et al, 1991) have proposed new clinic-diagnostic results of CIPC for its early diagnosis in 1991. Authors suggested ways for early diagnosis of CIPC by means of defining the abnormality of the specific laboratory indicators

range, such as serum toxicity index, PLO, chemiluminescence coefficient, sensitivity to YP, defining of sulfhydryl groups.

N. Ormanov (Ormanov, 1990) suggests studying the results of non-specific body resistant for evaluation of intoxication severity.

CIPC treatment is the problem, which is not totally solved. Most of the medicinal products, which have been used, affects only symptoms of disease. Influence of herbal medicinal products on pathobiochemical processes has not been fully studied taking into account sensitivity to xenobiotic and considering the leading role of prooxidant – anti-oxidant system damage in pathogenesis of phosphorous intoxication, which leads to imbalance of this system.

Nowadays, practical medicine has rather big quantity of antioxidant medicinal products. However, adverse effects and complications, which limit successful application of medicinal products in clinics, often appear within application of synthetic medicaments. Such situation causes the necessity of searching and studying new high-efficient medicinal products, particularly based on herbal substances, which have low toxicity in comparison with synthetic ones. Glycyrrhizic acid, which is extracted from the liquorice root, is of the utmost interest in this context (Trofimov, 1994).

Further study and searching of new bioactive derivative of liquorice is considered to be actual direction and remain to be one of the most valuable and prospective source for medicinal products development (Praliev et al, 2003).

Glycyrrhizic acid and its aglycon, i.e. glycyrrhetic acid, determine the basic medicinal properties of liquorice root. These glycosides and its different derivatives have wide range of bioactivity (Gibson, 1978; Norman, 1995).

Some data substantiates (Lykasova, 2000) the scientific-experimental validation of liquorice root application for reduction of negative effect of organochlorine pesticides and heavy metals on to animals' organisms.

Medicinal products, based on Urals liquorice and Amur cork tree, have been tested for the first time with the aim of wound healing effect of different animal specimen (Korotkova, 2003).

Liquorice can be used for wounds healing due to wound healing effect (Seksenaev et al, 2013)

Bioslastiline (BS) is the original herbal medicinal product made of liquorice root developed by Professor M. Irismetov (Irismetov, 1997).

Immunomodulatory effect of BS herbal medicinal product has been revealed while researching its pharmacological activity (Burkitbaeva, 2005).

According to some data (Zhakipbekova, 1999), bioslastiline has had distinct antiradical impact on free-radical processes within acute phosphorus intoxication.

Workers have taken 487,5 mg of dry liquorice root extract (LRE) and 100 mg of BS once a day during 10-14-20 days depending on sensitivity to YP (Ormanov and Adilbekova, 2011).

The goal of research is studying the dynamics of lipids and antioxidant system peroxidation characteristics of the blood of phosphorus plant workers depending on individual sensitivity to yellow phosphorus under the influence of liquorice herbal medicinal product.

2. Material and Methods

Blood, erythrocytes and plasma have been the materials for study. Research for defining the early, intermediate and end PLO products in plasma and blood erythrocytes: diene conjugates (DC), lipids hydroperoxide (LHP) and malondialdehyde (MDA), has been carried out in order to get complete idea regarding PLO kinetics in this work based on the methods of V. Gavrilov (Gavrilov and Mishkorudnaya, 1983), V. Mironchuk (V. Mironchuk, 1984), L. Andreeva (Andreeva, 1988) and others. Such methods as direct histochemical determination and polarographic registration are quite labor consuming and less precise.

Definition of DC in blood plasma and in erythrocytes have been carried out according to standard practice in modification of V. Gavrilov and M. Mishkorudnaya (Gavrilov and Mishkorudnaya, 1983) by ultraviolet spectrum of acidification primary product of unsaturated lipids with absorption maxima at 233 nm. Content of DC has been expressed in units of optical density (UOD) to mg/lipids.

Content of PLO – MDA end product in researched objects has been defined according to modified method of L. Andreeva (Andreeva, 1988).

Lipids oxidation reaction (LOR) of red-cells membranes has been defined according to method of V. Kulikova and others (Kulikov et al, 1976), and results have been expressed in E_{233nm} during 30 minutes of incubation per 150 millions of erythrocytes.

Determination of general antioxidant activity (AOA) has been performed by the method of E. Spector and others (Spector et al, 1984). Tocopherol research in plasma and blood erythrocytes has been defined according to the method of N. Rudakova-Shilina, N. Matykhova (Rudakova-Shilina and Matykhova, 1982). Determination of superoxide dismutase (SOD) has been performed by method of

C. Beauchamp, J. Fridovich (Beauchamp and Fridovich, 1971) in modification of V. Chumakova and L. Osinskaya (Chumakova and Osinskaya, 1977). SOD activity has been expressed in standard unit per one ml of erythrocyte concentrate.

Determination of glutathione peroxidase (GP) intensity has been based on changing the recovered glutathione absorption after incubation with hydrogen dioxide (Paglia and Valentine, 1967).

Intensity of glutathione reductase (GR) of erythrocytes has been based on spectrofluorimetric method by NADP oxidation date with acidified glutathione at 320 nm wavelength (Pinto and Bartley, 1969).

Content of sulfhydryl (SH) groups of whole blood has been defined using Ellman's reagent at spectrophotometer with 412 nm wavelength (Torchinskyi, 1977). SH-group level has been expressed in mCM/ml of blood.

We have defined chemiluminescent (ChL) results of biological matrixes of the body in plasma and blood hemolysate in accordance with the goal of this research work for studying the PLO processes of examined people.

Chemiluminescence method is the proper indicator of free-radical oxidative processes and activity of bioantioxidative body systems according to A. Zhuravlev (Zhuravlev, 1965). Changing of ChL parameters of biological medium of the body gives the opportunity of quantitative description of free-radical reactions, that is difficult to perform by other methods. 10-20 minutes are required for measurement of one ChL sample of hemolysate and this fact has determined the choosing of the method.

Blood is extracted from patients' finger (under fasting condition of the patients and in the morning) in amount of 0,1 ml and 1 ml in order to carry-out the analysis and then this blood with distilled water has been placed into device for ChL hemolysate.

Fluorescence research has been carried out in "Chemiluminometer ChLMZ - 01" device, which was developed in Radio-technical Institute of Kiev. New PMT-130 photomultiplier ("Quanton" type, England), which has from 300 up to 650 nm sensitivity, has been used as the detector of super-weak fluorescence.

Spontaneous fluorescence of hemolysate has been defined at first stage and then the intensity of ChL induced by hydrogen dioxide also has been defined. For this purpose, 0,5 ml of 3% hydrogen dioxide solution has been added into the flask through special input. After that, the definitive kinetics of fluorescence has been observed. It has been registered with the help of MAR-4 (monitoring automatic-recording) device. Ambient temperature during the experiment has been 37°C. The basic

characteristics of researched process of ChL were the intensity of spontaneous fluorescence and the induced fluorescence. Obtained results have been represented in imp./sec for spontaneous fluorescence and thousands of imp./5 min (total light sum) – for induced one.

Individual sensitivity of the body to YP has been determined by chemiluminescent method of D. Adilbekova and N. Ormanova (Adilbekova and Ormanov, 2008).

Method of determination: 1%-water suspension of YP is preliminary prepared. 1,0 of YP has been placed into 99 ml of distilled water and treated by ultrasound during 10 min at 22 KHz. UZDN-1 (radiant power: 400 watt) device has been used for ultrasound creation.

Blood has been taken from median cubital vein in amount of 1,0-1,2 ml. Then it has been shared in two parts. 0,01 ml 10^{-3} M of YP water suspension has been added to one part, and 0,01 ml of tris-HCL buffer at pH=6,8 has been added to the other part. Then these samples have been placed into thermostat for 30 minutes at T° -37°C. After that, the both samples have been centrifuged at 1500 rpm adding 0,01 ml of heparine. Then 0,4-0,5 ml of blood plasma has been obtained. Samples have been placed into chemiluminometer ChLMZ-01. Provocation has been performed by 0,5 ml of 3% hydrogen dioxide solution. Sample with phosphorous has been the "check sample" and the other one has been the "control sample". Initiation has been performed by H_2O_2 – luminol system. We defined total light sum during 5 minutes.

It was reasonable to express results as sensitivity coefficient (Cs), which shows the difference of ratio of check sample to the control one according to the following formula (1) (Adilbekova and Ormanov, 2008) for the convenience of the comparison:

$$C_s = \frac{\text{Light sum of plasma with phosphorus}}{\text{Ligt sum of plasma without phosphorous}}, \text{ relative unitet} \quad (1)$$

Research has been carried out at occupational pathology department of South-Kazakhstan branch of scientific centre of occupational hygiene and occupational diseases No.2 clinic of Taraz city. 72 probationary male employees of basic occupations with 5-10 years of employment length from Dzhambyl phosphorous plant and 148 CIPC diseased people have been examined.

Determination of anti-radical activity (ARA) of the blood has been performed by chemiluminescence method (Ormanov, 1986).

We have implemented integrated coefficient (IC) of LPO-ASF for easier analysis of free-radical PLO condition within exposure of YP and medicinal

products, including blood erythrocytes, which is calculated according to the following formula (2)

$$IC = \frac{\frac{ChL^*}{ChL^c} + \frac{DC^*}{DC^c} + \frac{LHP^*}{LHP^c} + \frac{MDA^*}{MDA^c}}{4} : \frac{\frac{ARA^*}{ARA^c} + \frac{AOA^*}{AOA^c} + \frac{TP^*}{TP^c} + \frac{GP^*}{GP^c} + \frac{GR^*}{GR^c}}{5} \quad (2)$$

being: ChL – chemiluminescence; DC - diene conjugates; MDA - malondialdehyde; LHP - lipids hydroperoxide; ARA - anti-radical activity; AOA – anti-oxidant activity; TP – α -tocopherol; GP – glutathione peroxidase; GR – glutathione reductase; * - test, c – control.

3. Results and discussion:

At the same time, we studied the changing of metabolism of PLO products in erythrocytes of the blood as the result of application of medicinal products based on liquorice root. We carried out clinic-biochemical research considering influence of LRE and bioslastiline on to condition of LPO and antioxidant mechanisms of blood of phosphorus plant workers in accordance with the tasks of the research.

Table shows the dynamics of PLO and LOR products' metabolism in blood's erythrocytes after application of BS by workers.

As the table shows, the content of PLO products in blood's erythrocytes of workers is changing depending on sensitivity to xenobiotic. Content of DC, LHP and MDA exceed the results of control groups (CG) by 38,%, 37,8% and 35,3%, whereupon reaction of oxidation has been increased by 70%. Concentration of DC, LHP and MDA in blood of "sensitive" workers exceed the results of CG by 115,4%, 113,4% and 109,5%, whereupon reaction of oxidation has been increased by 160%. Content of DC, LHP and MDA in blood of "very sensitive" workers exceed the results of CG by 265,4%, 162,3% and 255,6%, whereupon reaction of oxidation has been increased by 240%.

Research has showed that accumulation level of DC, LHP and MDA in the blood is depending on individual sensitivity of the body to YP.

Content of DC, LHP and MDA in erythrocytes of the "resistant" workers blood has been decreased by 16,7%, 13% and 15,1% in comparison with baseline result after LRE application. However, its concentration remains increased by 15,4%, 20% and 14,9% in comparison with CG. LOR in red-cell membranes has been decreased by 11,8% after LRE application, however, it remains increased in comparison with CG by 50% (table 1).

Concentration of DC, LHP and MDA in blood's erythrocytes of "resistant" workers after prophylactic application of bioslastiline has been reduced by 38,9%, 28,4% and 29,5% in comparison with baseline results and achieves the results of CG. LOR in red-cell membranes has been reduced by 47,10% after bioslastiline application and achieves the results

(Ormanov, 2005).

of CG.

Content of DC, LHP and MDA in blood's erythrocytes of "sensitive" phosphorus plant workers after LRE application has been decreased by 14,3%, 14,6% and 13,4% in comparison with baseline results, however their concentration remains increased by 84,7%, 82,3% and 81,4% in comparison with CG. LOR in red-cell membranes has been decreased by 15,4% after LRE application, however, it remains increased in comparison with CG by 120%.

Results of lipids hyper-peroxidation after prophylactic application of BS during 10 days have demonstrated some reduction of PLO products concentration in blood's erythrocytes of "sensitive" workers of the phosphorus plant. Content of DC, LHP and MDA has decreased by 50%, 41,7% and 41,8% after BS application, in comparison with baseline result, however, their concentration remains increased by 7,7%, 24,5% and 21,9% in comparison with CG. PLO in red-cell membranes have reduced by 34,6% after bioslastiline application, however it remains increased in comparison with CG by 70%.

Research results demonstrate that BS has positive effect onto LPO processes, that is proved by reduction of ChL of blood hemolysate characteristics and reduction of PLO products content. Inhibitory effect is more expressed in case of treatment of workers who are "resistant" to YP. However PLO results in erythrocytes of "sensitive" and "very sensitive" workers remain increased more than in 1,5 times after 10 days of BS application.

Content of DC, LHP and MDA in blood erythrocytes of "very sensitive" workers have decreased by 14,5%, 15,3% and 15,1% after LRE application, in comparison with baseline result, however, their concentration remains increased by 127,5%, 122,3% and 217,7% in comparison with CG. LOR in red-cell membranes has decreased by 14,7% after LRE application, however, it remains increased in comparison with CG by 190%.

Prophylactic application of BS during 10 days has reduced concentration of PLO products in blood's erythrocytes of "very sensitive" workers of phosphorus plant. Content of DC, LHP and MDA has

decreased by 50%, 41,7% and 52,5% in comparison with baseline result after BS application, however its concentration remains increased by 46,2%, 51,2% and 45,2% in comparison with CG. LOR in red-cell membranes has decreased by 40,1% after BS application, however it remains increased in 2 times in comparison with CG.

Results of research demonstrate positive effect

of BS on to processes of free-radical PLO in comparison with LRE, which is proved by decreasing of ChL of blood hemolysate and reducing of PLO products content. However, results of PLO in erythrocytes of “sensitive” and “very sensitive” workers remain increased more than in 1,5-2 times after 10 days of BS application.

Table 1 – dynamics of PLO and LOR products’ metabolism in blood’s erythrocytes of phosphorus plant workers after 10 days of bioslastiline application in dependence of sensitivity to xenobiotic

Groups Results	Phosphorus plant workers				
	Control group		Resistant	Sensitive	Very sensitive
DC content (uod /mg lipids)	0,26±0,03	1	0,36±0,02*	0,56±0,03*	0,69±0,02*
		2	0,30±0,01*	0,48±0,02*	0,59±0,02*
		3	0,22±0,01*	0,28±0,02*	0,38±0,03*
		4	0,23±0,01	0,25±0,02	0,30±0,01
		5	0,24±0,02	0,26±0,02	0,25±0,02
LHP content (uod/mg lipids)	2,25±0,01*	1	3,1±0,10*	4,8±0,26*	5,9±0,22*
		2	2,7±0,07*	4,1±0,16*	5,0±0,21*
		3	2,2±0,10	2,8±0,27*	3,4±0,17*
		4	2,2±0,10	2,3±0,10	2,7±0,02
		5	2,3±0,11	2,4±0,11	2,2±0,01
MDA content (mcM/mg)	40,3±5,1	1	54,5±2,9*	84,4±3,9*	103±6,7*
		2	46,3±2,0*	73,1±3,1*	87,5±3,8*
		3	39±1,5*	49,1±2,4*	58,5±2,7*
		4	38±1,4*	39,2±1,5	45,8±1,3
		5	37±1,3*	38,2±1,4	40,4±1,1
Lipids oxidation reaction (uod/150 ml/ml)	0,10±0,01	1	0,17±0,005*	0,26±0,01*	0,34±0,01*
		2	0,15±0,002*	0,22±0,005*	0,29±0,01*
		3	0,09±0,001	0,17±0,006*	0,20±0,005*
		4	0,08±0,003	0,12±0,007	0,16±0,01*
		5	0,07±0,002	0,11±0,007	0,11±0,01
Comments					
1- baseline result;					
2 – after LRE application;					
3 – after 10 days of bioslastiline application;					
4 - after 14 days of bioslastiline application;					
5 – after 20 days of bioslastiline application;					
6 - * p<0,05, - confidence coefficient in comparison with control group.					

Prophylactic application of BS during 14 days decreases content of DC, LHP and MDA in blood’s erythrocytes of “sensitive” workers by 10,7%, 17,8% and 20,1% in comparison with 10 days application result, and also these results decreased by 21%, 20,5% and 21,7% of “very sensitive” to YP workers. However, they remain increased by 15,4%, 20% and 13,7% in comparison with CG results. LOR in red-cell membranes of “sensitive” workers is decreasing by 41,1% and achieves CG results, and “very sensitive” to YP workers have 20% decreased results, but remain increased by 60% in comparison with CG results. 20 days application of BS by “very sensitive”

workers decreases concentration of DC, LHP, MDA and LOR in blood’s erythrocytes by 34,2%, 35,3%, 30,9% and 45% in comparison with 10 days application results.

ASF parameters of the workers blood are decreasing depending on sensitivity to xenobiotic. SOD intensity of “resistant”, “sensitive” and “very sensitive” groups decreases by 20,6%, 44,8% and 50,5% in comparison with CG. GP intensity of blood of “resistant”, “sensitive” and “very sensitive” groups of workers decreases by 25,3%, 40,6% and 50,9% in comparison with CG. GR intensity of blood of “resistant”, “sensitive” and “very sensitive” groups of

workers decreases by 11,7%, 28,2% and 42,4% in comparison with CG. Content of SH-group of the blood of “resistant”, “sensitive” and “very sensitive” group of workers decrease by 12,5%, 27,8% and 41,9% in comparison with CG. Concentration of α -tocopherol of the blood of “resistant”, “sensitive” and “very sensitive” groups of workers decrease by 18%, 40,6% and 47,49% in comparison with CG. ARA of the blood of “resistant”, “sensitive” and “very sensitive” groups of workers decreases by 20%, 41,3% and 49% in comparison with CG. AOA of the blood of “resistant”, “sensitive” and “very sensitive” groups of workers decreases by 20,1%, 41,3% and 48% in comparison with control group. IC of LPO-ASF of the blood of “resistant”, “sensitive” and “very sensitive” groups of workers increases by 90%, 290% and more than in 7 times in comparison with CG.

There are no changes of ASF intensity and content of nonenzymatic indicators of the blood as the result of prophylactic application of LRE by “resistant” workers. BS application during 10 days increases SOD, GP and GR intensity by 27,9%, 35,8% and 15,1% in comparison with baseline results. Content of α -tocopherol and SH-groups in the blood has increased by 15,1% and 21,6% in comparison with baseline result. ARA and AOA of liquid part of the blood have increased by 24,3% and 24% under the influence of BS in comparison with baseline result. IC of LPO-ASF of “resistant” to YP workers reduces by 47,3% in the blood after 10 days of BS application due to LPO inhibition and ASF activation.

There is no change of ASF intensity and content of non-enzymatic blood results of “sensitive” groups due to prophylactic application of LRE. Application of BS during 10 days by these workers increases intensity of SOD, GP and GR by 44,8%, 37,2% and 36,6% in comparison with baseline result. Content of α -tocopherol and SH-groups in blood have increased by 22% and 13,3% in comparison with baseline result. ARA and AOA of liquid part of blood have increased by 24,4% and 23,6% in comparison with baseline result under the influence of BS.

There is the reduction of IC of LPO-ASF by 58,9% of “sensitive” groups of workers under the influence of 10 days of BS application, however it remains increased by 60% in comparison with CG.

There is no change in ASF intensity and in content of non-enzymatic blood results of “very sensitive” groups as the result of prophylactic application of LRE. Intensity of SOD, GP and GR increases by 44,5%, 36,7% and 39,1% in comparison with baseline result in case of BS application during 10 days.

Content of α -tocopherol and SH-groups in blood has increased by 22,1% and 17,7% in comparison with baseline result. ARA and AOA of liquid part of blood have increased by 22% and 26,6% in comparison with baseline result under the influence of BS. There is the reduction of IC of LPO-ASF by 52,3% of “very sensitive” groups of workers under the influence of 10 days of BS application, however it remains increased more than in 4 times in comparison with CG (table 2).

Considering the data, that LPO in blood of “sensitive” and “very sensitive” groups of workers after 10 days of BS remain increased, and results of blood’s ASF remain liquefied, ASF of the blood have been studied after 14 days of BS application by “sensitive” workers and after 20 days – by “very sensitive” to YP workers (table).

As it can be seen from research results of ASF of workers, who are “sensitive” to YP, ASF increases and achieves the level of CG after 14 days of BS application. Intensity of SOD, GP and GR of “sensitive” groups after 14 days of BS application increases by 78,8%, 66,6% and 40,6%; content of SH-groups and α -tocopherol increases by 38,4% and 68,7%; ARA and AOA of blood’s plasma increases by 67,9% and 67%; IC of LPO-ASF has decreased in 3,3 times in comparison with baseline result and achieves CG result.

ASF of “very sensitive” to YP workers increases in case of 20 days of BS application in comparison with the result of 10 days application. Intensity of SOD, GP and GR in blood’s erythrocytes of these workers increases by 39,9%, 48,4% and 25,7% and achieves the results of CG. Content of SH-groups and alpha-tocopherol in blood increases by 46,6% and 55,6% after 20 days of BS application and approximates to CG result. ARA and AOA increase by 60% and 50,4% and achieve the CG results. IC of LPO-ASF of “very sensitive” to xenobiotic workers decreases by 71,2% and approximates to CG result under the influence of 20 days of BS application.

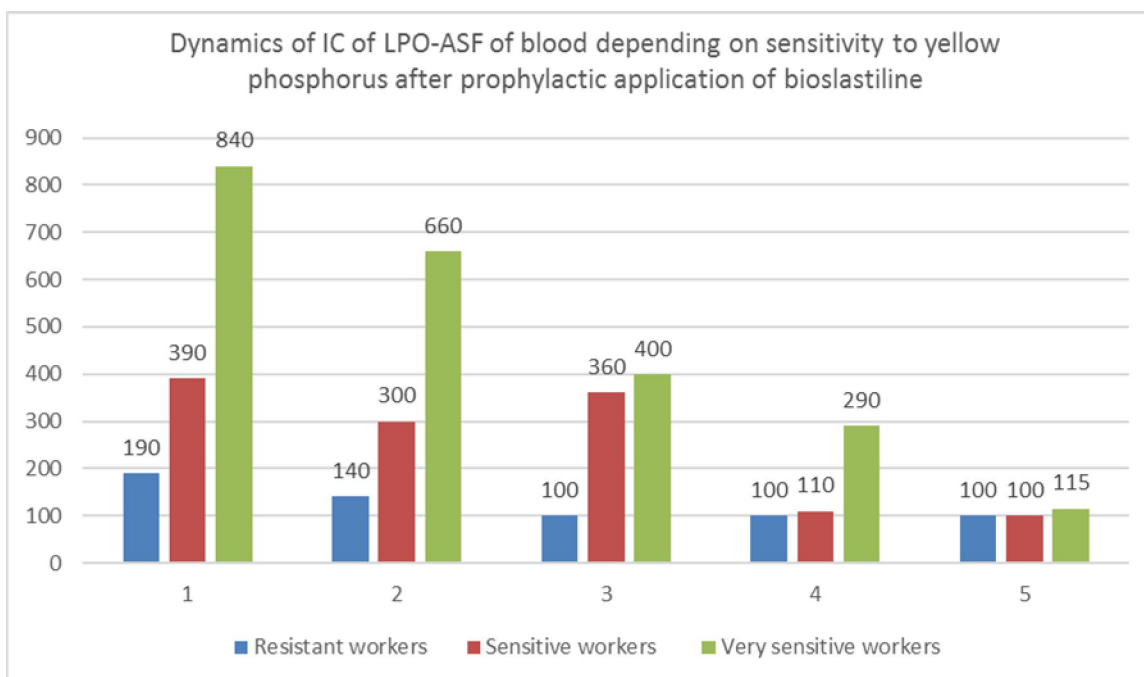
Therefore, accumulation of lipids hyperoxides in red-cell membranes with reducing of antioxidant mechanisms at the same time depends on sensitivity of phosphorus plant workers to xenobiotic. Imbalance of LPO-ASF in blood and particularly in blood’s erythrocytes has gone along with activation of chemiluminiscent properties of blood hemolysate and depression of ASF parameters. Integrated coefficient of LPO-ASF imbalance in erythrocytes has increased in one direction depending on sensitivity of workers to YP.

Table 2 – dynamics of antioxidant systems in blood of phosphorus plant workers under the influence of bioslastiline depending on sensitivity to yellow phosphorus

Groups Results	Workers				
	Control group		Resistant	Sensitive	Very sensitive
SOD (stand.unit/10 ⁶)	69,2±2,0	1	54,9±0,72*	38,2±0,85*	34,2±1,2*
		2	57,3±3,2*	42,1±2,1*	37,5±1,3*
		3	70,2±4,1	55,3±2,3*	49,4±1,4*
		4	68,6±3,1	68,3±3,1	60,1±2,3*
		5	68,9±3,4	69,1±3,3	69,1±2,1
GP (stand.unit /10 ⁶)	36,7±1,9	1	27,4±1,6*	21,8±0,66*	18,0±0,7*
		2	31,5±1,6*	23,5±1,1*	19,5±0,9*
		3	37,2±2,1	29,9±1,4*	24,6±1,0*
		4	36,4±1,9	36,3±1,8	30,8±1,5
		5	36,5±1,8	36,6±1,6	36,5±1,7
GR (mcM NADP per 1,0 ml er.)	55,6±1,6	1	49,1±2,4*	39,9±1,7*	32,0±1,4
		2	50,5±2,1*	45±2,1*	33,0±1,7*
		3	56,5±3,1	54,5±2,3	44,5±1,4*
		4	56,1±2,4	56,1±2,4	44,9±2,4
		5	55,6±2,0	56,3±2,1	55,9±2,7
SH (mcM/10 ⁶)	57,5±1,6	1	50,3±1,5*	41,5±0,72*	33,4±0,59*
		2	51,7±2,3*	43±1,1*	34,6±0,7*
		3	57,9±1,3	47±1,1*	39,3±0,9*
		4	56,1±2,4	56,1±2,4	46,4±2,1
		5	56,9±2,4	57,1±2,4	57,6±2,4
α-tocopherol (mcg/g)	0,544±0,01	1	0,446±0,01*	0,323±0,01*	0,286±0,01*
		2	0,456±0,01*	0,333±0,02*	0,297±0,02*
		3	0,542±0,02	0,394±0,02*	0,349±0,02*
		4	0,541±0,02	0,542±0,03	0,469±0,03*
		5	0,540±0,03	0,541±0,04	0,543±0,03
ARA (stand. unit)	57,3±2,8	1	45,8±2,1*	33,6±1,5*	29,2±1,4*
		2	46,4±2,3*	35,4±1,6*	30,3±1,4*
		3	56,9±2,1	41,8±2,1*	35,6±1,3*
		4	56,8±2,0	56,4±2,5	48,1±2,3*
		5	56,7±2,0	55,9±2,6	57,1±2,4
AOA (stand. unit)	37,7±1,2	1	30,1±1,3*	22,1±1,1*	19,6±0,92*
		2	31,3±1,5*	23,4±1,3*	20,3±1,*
		3	37,3±1,4	27,3±1,4*	24,8±1,1*
		4	37,2±1,3	36,9±1,3	33,1±1,5
		5	37,1±1,2	36,8±1,2	37,3±1,6
IC of LPO-ASF	1,0±0,05	1	1,9±0,09*	3,9±0,02*	8,4±0,50*
		2	1,4±0,07*	3,0±0,01*	6,6±0,3*
		3	1,0±1,4	1,6±0,07*	4,0±0,24*
		4	1,0±1,3	1,1±0,07	2,9±0,13*
		5	0,9±1,2	1,0±0,06	1,15±0,07*
Comment					
1- baseline result;					
2 – after LRE application;					
3 – during 10 days after bioslastiline application;					
4 - during 14 days after bioslastiline application;					
5 – during 20 days after bioslastiline application;					
6 - * p<0,05,- confidence factor in comparison with control group.					

There is the data that results of LPO in blood of “sensitive” and “very sensitive” groups of workers remain increased and ASF results remain decreased after 10 days of BS application. Dynamics of IC of

LPO-ASF after 14 days of BS application by “sensitive” workers and after 20 days of bioslastiline application by “very sensitive” to YP workers has been traced based on this data (chart).



Comment: 1 – before medicinal products application; 2 – after 10 days application of LRE; 3 – after 10 days of BS application; 4 – after 14 days of BS application; 5 – after 20 days of BS application.

IC of LPO-ASF after 14 days of BS application by “sensitive” workers has decreased by 46,6% in comparison with 10 days and approximates to CG results, and decreased by 45,2% in case of application by “very sensitive” group and remains increased by 51% in comparison with CG result. IC has decreased by 60,3% after 20 days of BS application by “very sensitive” to xenobiotic group of workers in comparison with 14 days of BS application and approximates to CG result.

Therefore, the most reasonable and effective application of BS by workers depending on sensitivity to YP is observed in case of 10 days of application by “resistant” workers, 14 days – by “sensitive” and 20 days – by “very sensitive” workers. It is proven by decreasing of integrated coefficient of LPO-ASF of the blood.

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