The influence of phytomedicine on the condition of lipid peroxidation in immunocompetent organs and tissues of irradiated organism

Oralbek Ilderbayev, Ainur Argynbekova, Nazym Kudaibergenova, Asylzhan Mesova, Meruyert Mukasheva, Darkhan Uzbekov, Bakytbek Sovetov, Karlygash Kaliekova

Semey State Medical University, Abay str., 103, Semey, 071400, Kazakhstan

Abstract. The animals were exposed to ionizing radiation (gamma-radiation ^{60}Co) on the radiotherapeutic equipment "Teragam" in a dose of 6 Gy and received phyto medicine Epb in a dose of 35 mg/kg orally within 14 days following the ionizing radiation exposure. Gamma-rays caused the increase of lipid peroxidation (LPO) primary (CD-conjugated dienes) and secondary products' (MDA-malonic dialdehyde) concentrations in spleen, liver, thymus and adrenal glands. Treatment by phytomedicine Epb resulted in contents of conjugated dienes decreased in 3.3 times in spleen, in 7.3 times in thymus, in 5.2 times in adrenal glands, in liver in 4.71 times, in lymph nodes of small intestine it in 3.69 times. Malonic dialdehyde decreased in liver up to 6.2 and 3.78 times, in spleen in 3.3 times, in thymus in 9.5 times, in liver in 6.21 times, in adrenal glands in 12.6 time, no changes in lymph nodes of small intestine. Conclusions: The effect of Epb phytomedicine treatment of organisms exposed to sublethal dozes of gamma-radiation results in the LPO primary and secondary products concentrations decrease in spleen, liver, thymus and adrenal glands.

[Ilderbayev O., Argynbekova A., Kudaibergenova N., Mesova A., Mukasheva M., Uzbekov D., Sovetov B., Kaliekova K. **The influence of phytomedicine on the condition of lipid peroxidation in immunocompetent organs and tissues of irradiated organism.** *Life Sci J* 2014;11(5s):276-279] (ISSN:1097-8135). http://www.lifesciencesite.com. 54

Keywords: phytomedicines, radiation, lipid peroxidation.

Introduction

Today, the explored flora of Kazakhstan accounts more than 6000 of plant species, out of which 150 are being utilized in current medical practice. For this reason, a great perspective belongs to further chemical research of earlier found but not previously explored species, search of new sources of valuable biologically active bonds and synthesis of new biologically active derivants on the basis of plant materials. One of the promising species which could be used for the derivation of drugs and biologically active mixtures is the poplar balsamic (Populus balsamifera), which contains up to 70 biologically active substances of different classes of natural bonds: poly-Phenols, adipose and organic acids, vitamins, trace substances, tannic materials, lignines and essential oils. The new natural materials obtained from a poplar balsamic have apparent advantage over synthetic medical drugs currently applied in practice, in terms of efficacy, safety and accessibility [1, 2].

By the group of scientists Simard et al.were investigated properties of the extracted of Populus balsamifera. A phytochemical investigation of an ethanolic extract from Populus balsamifera L. buds resulted in the isolation and characterization of twelve new flavan derivatives consisting of six pairs of enantiomers. Structures of (+) and (-) - balsacones D-I were elucidated based on spectroscopic data (1D and 2D NMR, MS) and their absolute configurations were established using X-ray single crystal diffraction analysis and ECD computational calculations. Antibacterial activity and cytotoxicity of all purified enantiomers were evaluated in vitro against Staphylococcus aureus and human skin fibroblast cells, respectively [3].

Populus balsamifera extracts completely abrogated adipogenesis, severely limited clonal expansion of pre-adipocytes and generally maintained cells in an undifferentiated fibroblast-like morphology. Populus balsamifera extracts exerted antagonistic action against PPAR - γ activity. It is concluded that, through their actions on the adipocyte, these plant products may be useful for the treatment of obesity and related metabolic diseases [4].

The researchers obtained results confirm the potential of Populus balsamifera as a culturally adapted therapeutic approach for the care and treatment of obesity and diabetes among the Cree [5].

The study of the rough-bark poplar oil and drooping birch extracts impact on the antioxidant system of the organism in case of acute hypoxia revealed positive effect of these solutions. The undertaken research suggests the pronounced antioxidant and hepatoprotectoral properties of natural polyphenol compounds and also of the extracts of some vegetative organs of the studied plants. Thus, the pronounced antioxidant activity of polyphenol compounds contained in the rough-bark poplar oil and drooping birch extracts. The comparative analysis of antioxidant activity of rough-bark poplar oil and drooping birch extracts using different methods in vitro showed the existence of correlation dependence between the AOA indicators and content of certain flavonoids [6, 7].

For this reason it appears to be important to undergo the "Topolin" medicine to a further study in order to establish it's pharmacological activity as well as to explore the pharmaceuticals obtained from this substance. The medical forms of drugs produced on the basis of poplar buds ("Topolin") have anti-inflammatory, antimicrobial and injury-healing effects, which was confirmed by clinical studies of various patients affected by different diseases [8, 9]. On the basis of above stated the conclusion of importance of continuous research of poplar balsamic based drugs appears to be obvious. It might prove to be useful to stimulate the broader implementation of these medicines in clinical practice.

The present paper describes the influence of phytomedicine Epb ("Topolin" substance) on the metabolic processes (peroxide oxidation of lipids) in immune competent organs and tissues of white rats undergone to ionizing radiation.

The study of Peroxide lipids oxidation (PLO) process is used as one of stability parameters of organism's changes and as a key mechanism for understanding of adaptation reactions and of pathogenesis of different diseases. It's determined by high biological activity of products which are formed in the PLO reactions, in this relation lipids with high contents of fat acids play important role. As known, the increase of CD and MDA concentrations' certifies the structural affection of biolipids in cellular membranes of radiation genesis. Intensification of peroxides and free-radicals substances formation together with impairment of mechanisms of cellular defense may result in serious structural violations and metabolic changes of cells.

The purpose of this experimental research is to study the influence of phytomedicine Epb on metabolic processes of white rats undergone to ionizing radiation.

Material and methods

To investigate the lipid peroxidation of laboratory animals (white rats) in three series of experiments. The overall number of white mature rats was equal to 45 with body mass varying from 220 to 250 grams. All rats were divided into 3 groups: I – controls (n=15), II group – animals exposed to radiation (n=15), III – animals exposed to radiation and received supplementation of phytomedicine Epb (n=15). The animals of the II and III series were exposed to γ-rays ^{60}Co in a Teragam γ-therapy apparatus. Before the exposure, topometry and dosimetry of the rats was performed. To this end, the object was placed on an isocentric therapeutic table of Terasix X-ray simulator, which is similar to the therapeutic table of the γ-apparatus by its construction and parameters. The images of irradiated animals after displaying were directly input in the planning system using network connection with the computer by electronic tablet. Isodoses were calculated using planning software Plan W-2000, and the image with radiotherapy plan with technical characteristics and planning radiation doses was obtained. The animals were exposed to single whole-body radiation in a dose of 6 Gy. During the exposure, animals were placed in a specially engineered cage made of organic glass with individual compartments for each rat. In the II group animals were examined 30 days after irradiation. The animals of the III group received phytomedicine Epb in a dose of 35 mg/kg orally within 14 days following the ionizing radiation exposure. Experiments were performed in accordance to the order of the Ministry of Public Health of USSR (12.08.1977), Geneva Conventions, and Declaration of Helsinki on Animal's Welfare. The study protocol was approved by the Local Ethics Committee of the Semey State Medical University, Semey, Kazakhstan with the number of No2 dated September, 2013.

The levels of LPO, CD (conjugated dienes) and MDA (malon dialdehyde) in thymus, spleen, liver, lymph nodes of small intestine and adrenal medulla were tested. Primary products of LPO metabolism – CD (conjugated dienes) were formed due to the migration of double bonds of lipidacidacils, with 2 or 3 double bonds causing changes in phospholipids' membranes. Secondary product of PLO's metabolism is MDA which form in the destruction of the hydroperoxides lipids and phospholipids.

The obtained data were statistically analyzed; the significance of differences was estimated using Student's *t* test [10].

Results

The results of the phytomedicine Epb influence on CD contents of exposed animals is shown in table. As this table presents, in the II series of experiment 30 days after irradiation by common gamma-rays in the dose equal to 6 Gray, the reliable increase of CD contents was observed, that was 2.75 times higher in liver, 1.37 times higher in lymph nodes of small intestine, 2.5 times higher in thymus, and 2.38 times higher in spleen ($p<0.05$) as compared to control animals. The decrease of CD concentration in adrenal medulla under the influence of ionizing radiation was observed in 1.93 times ($p<0.05$) as compared with the control group.

Table 1. The influence of the Epb phytomedicine on DC and MDA of exposed rats

Body organs	1 group (control animals) n=15	2 group (exposed animals) n=15	3 group (exposed+Epb supplementation) n=15
DC, measurement unit – conditional units 1 ml			
Liver	0.36±0.03	0.99±0.06 *	0.21±0.01 *0
Spleen	0.21±0.02	0.50±0.03 *	0.15±0.05 *0
Lymph nodes of small intestine	0.35±0.03	0.48±0.04 *	0.13±0.03 *0
Thymus	0.42±0.04	1.10±0.08 *	0.15±0.05 *0
Adrenal glands	1.20±0.10	0.58±0.04 *	0.11±0.036 *0
MDA, measurement unit – mole/mgr			
Liver	1.44±0.13	2.36±0.09 *	0.38±0.02 *0
Spleen	1.18±0.11	2.00±0.17 *	0.61±0.021 *0
Lymph nodes of small intestine	0.051±0.004	0.060±0.005	0.063±0.006
Thymus	1.25±0.11	2.10±0.05 *	0.22±0.01 *0
Adrenal glands	1.12±0.10	1.90±0.15 *	0.15±0.01 *0

Note: * – statistically significant in relation to the 1 group of animals ($p<0.05$), 0 – statistically significant in relation to the 2 group of animals ($p<0.05$)

Three series of experiments show us, that under the influence of Epb phytomedicine the contents of CD in exposed animals decreased in 3.3 times in spleen, in 7.3 times in thymus and in 5.2 times in adrenal glands ($p<0.05$). The CD concentration in liver decreased in 4.71 times as compared with the 2 group ($p<0.05$), while in lymph nodes of small intestine it decreased in 3.69 times.

The data of experiment results by lowering of primary product of Peroxide lipids oxidation (PLO) in all investigated organs. As table 1 presents, examination of MDA concentrations in liver, thymus, spleen and lymph nodes of small intestine and adrenal glands 30 days after exposure to common gamma-rays in a dose of 6 Gray in the II series of this experiment, show that the MDA amounts significantly increased in thymus (from 1.25±0.11 to 2.11±0.05) and in spleen (from 1.18±0.11 to 2.0±0.17 ($p<0.05$). The MDA concentration in adrenal glands of exposed rats as compared with unexposed animals show increase to 55% and 67%, accordingly. The increase of MDA concentration in liver was equal to 1.63 times. No changes were observed in lymph nodes of small intestine.

In the 3 series of experiments at usage phytomedicine Epb the concentration of MDA decreased in liver up to 6.2 and 3.78 times as compared to the 1 and 2 groups. The significant decrease of MDA concentration also occurred in spleen (in 3.3 times), in thymus (in 9.5 times), in liver (in 6.21 times) and in adrenal glands (in 12.6 times) as compared with the 2 group. No changes were present in lymph nodes of small intestine.

Finally, obtained research results show that in case of exposure to common gamma-rays in a dose of 6 Gray, the concentrations of CD and MDA increase in liver, thymus, spleen and adrenal glands. Under the influence of Epb phytomedicine, the primary and secondary products of peroxide lipids metabolism decrease in spleen, liver, thymus and adrenal glands of exposed organism. However, no changes in MDA concentrations were observed in lymph nodes of small intestine in animals exposed to ionizing radiation and received Epb phytomedicine as a supplementation. Our research work results prove the fact of antioxidant properties of phytomedicine Epb ("Topolin" substance) in case of organisms exposed to ionizing irradiation.

Conclusion

1. The exposure to common sub-lethal dozes of gamma-radiation causes the increase of PLO primary and secondary products' concentrations in spleen, liver, thymus and adrenal glands.

2. The effect of Epb phytomedicine on the LPO's primary and secondary products concentrations decrease in spleen, liver, thymus and adrenal glands of exposed organisms.

Acknowledgements

This article was prepared under a grant from the Ministry of Education and Science of the Republic of Kazakhstan

Corresponding Author:
Dr.Ilderbayev Oralbek
Semey State Medical University, Kazakhstan
Abay str., 103, Semey, 071400, Kazakhstan
e-mail: oiz5@yandex.ru

References

1. Adekenov, S.M., 2004. Biologically active substances of herbal origin in newly developed medicines. Development of phytochemistry and prospects for creation of new medical drugs. Almaty: Gylym, pp: 7-17.
2. Isayeva, E.V., 2008. Biological activity of extracts and essential oils of kidney of the poplar of Krasnoyarsk area. Raw materials of chemistry plant, 1: 67-72.
3. Simard, F., J. Legalut, S. Lavoie and A. Pichette, 2014. Balsacones D-I, dihydrocinnamoyl flavans from Populus balsamifera buds. Phytochemystry. Date Views 20.01.2014 www.ncbi.nlm.nih.gov/pubmed/24485585.
4. Martineau, L.C., J. Herve, A. Muhamad, A. Saleem, C.S. Harris, J.T. Arnason and P.S. Haddad, 2010. Anti-adipogenic activities of Alnus incana and Populus balsamifera bark extracts, part I: sites and mechanisms ofaction. Planta Med, 76(13):1439-46.
5. Harbilas, D., A. Brault, D. Vallerand, L.C. Martineau, A. Saleem, J.T. Arnason, L. Mussallam and P.S. Haddad, 2012. Populus balsamifera L. (Salicaceae) mitigates the development of obesity and improves insulin sensitivity in a diet-induced obese mouse model. J Ethnopharmacol, 141(3):1012-20.
6. Mashentseva, A.A., L.V. Yushina, A.T. Kazbekova, B.I. Tuleuov, M.U. Lezhneva, S.M. Adekenov and T.S. Seitembetov, 2009. Investigation of the birch extracts effect on the phospholipids level in oxidation stress. 8 International Symposium on the Chemistry of Natural Compounds, Eskisehir (Turkey), pp: 146.
7. Mashentseva, A.A., T.S. Seitembetov, A.T. Kazbekova, A.T. Kulmagambetova, B.I. Tuleyov, M.U. Lezhneva and V.V. Polyakov, 2009. Comparative studies the antioxidant activity of polyphenols and endemic Kazakhstan plants throught in vitro and in vivo methods. Journal of the Technical University at Plovdiv “Fundamental Sciences and Applications”, 14(2): 485-491.
8. Polyakov, V.V., 2004. Creation of highly-effective phytomedicines on the basis of Northern Kazakhstan flora. Development of phytochemistry and prospects of creation of new medical drugs. Almaty: Gylym, pp: 199-216.
9. Isidorov, V.A. and V.T. Vinogorova, 2003. GC-MS analyses of compounds extracted from buds of Populus balsamifera and Populus nigra. Z Naturforsch, 58(5-6): 355-360.
10. Glants, S., 1999. Medico-biological Statistics. Moscow.

25/03/2014