INFLUENCE OF DEUTERIUM DEPLETED WATER ON INDICATORS OF PROOXIDANT-ANTIOXIDANT AND DETOXIFYING SYSTEMS IN EXPERIMENTAL DIABETES

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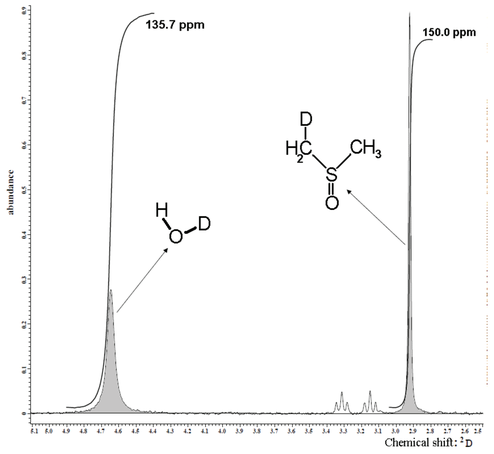
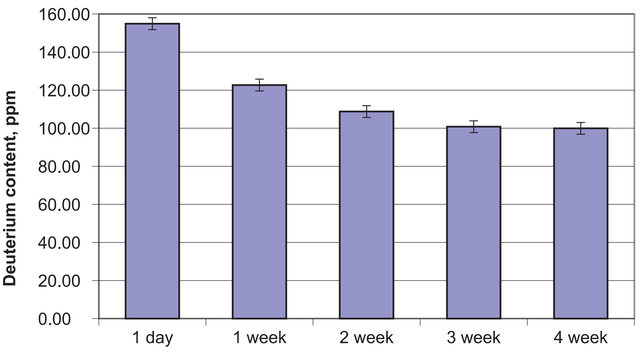
Study of the effect of deuterium depleted water (DDW) on isotopic D/H composition and condition of the antioxidant-prooxidant balance in plasma and lyophilized tissues of visceral organs (liver, kidney) were carried out in rats. Rats were divided into 2 groups. They received a single intraperitoneal injection of alloxan (at a dose of 17 mg per 100 g body weight) throughout the experimental diabetes. Group 1 (n=15) consumed mineralized water (150 ppm by deuterium), group 2 (n=15) consumed mineralized DDW (40 ppm) for 30 days before the creation of experimental model of diabetes. On day 5 after injection of alloxan in rats of both groups we observed increase in blood glucose level in 2.2 times increase in the activity of aspartate aminotransferase and alanine aminotransferase (which characterize cytolytic processes at the cellular level), increasing concentrations of creatinine, bilirubin and urea.

It was found that in the group 2 on 45th day after the start of the use 40 ppm DDW in the blood plasma decreased to 99,7±0,4 ppm ($p<0,05$), which was on 34.1% lower compared with group 1 ($p<0,05$). In addition, the integrated indicator of the functioning of the low molecular pool of prooxidant-antioxidant system in blood (coefficient of oxidative modification biomolecules of erythrocytes - Patent No 2236008 RU) in group 1 was on 17.9% higher than in group 2 ($p <0,05$), indicating that the perspective of using DDW at the complex correction of metabolic disorders in the antioxidant system of blood, observed during the development of diabetes. When studying the intensity of free radical oxidation in lyophilized tissue homogenates of visceral organs amount of free radicals (by EPR (electron paramagnetic resonance) spectroscopy data) in 1 group was higher in liver on 38.2%, and in the kidney on 34,6% ($p<0,05$ in comparison with group 2). There was an expressed decrease in the concentration of endogenous toxic substances in the blood of rats from group 2, associated with decrease of hypercatabolic processes due to the development of an experimental animal diabetes. This was confirmed in the group 2 by lower values of the integral index of endogenous intoxication (94.2% of hypercatabolism, $p<0,05$) compared with group 1 (129.3% of hypercatabolism). This indicates about increase in the functional activity of detoxification system and increase of nonspecific resistance of the organism during administration of DDW diet in rats.



Pic. 1.
Ratios of the integral intensities of the 2D NMR signal of HDO with respect to the 2D NMR signal of DMSOD1
(Baryshev M. G., Basov A. A., Dzhimak S. S. et al. NMR, EPR, and Mass Spectroscopy Estimates of the Antiradical Activity of Water with Modified Isotope Composition // Bulletin of the Russian Academy of Sciences. Physics, 2012, Vol. 76, No. 12, pp. 1349–1352).



Pic. 2.
Dynamics of the deuterium content in the blood plasma of laboratory animals consuming water containing 40 ppm
(Dzhimak S. S., Barishev M. G., Basov A. A., Timakov A. A. Influence of deuterium depleted water on freeze dried tissue isotopic composition and morphofunctional body performance in rats of different generations // Biophysics, 2014, Vol. 59, No. 4, pp. 614–619).

Biochemical indicators of prooxidant-antioxidant system and detoxification system in experimental diabetes

Indicator	Normal rate	Group 1	Group 2
AST, IU/L	163,20±11,65	192,49±8,67*	182,71±9,60*
ALT, IU/L	45,03±2,89	106,92±4,73*	97,64±3,28*
Albumin, g/L	32,51±1,79	32,38±1,62	33,59±2,12
Bilirubin, µmol/L	5,78±0,27	8,34±0,30*	8,29±0,17*
Creatinine, µmol/L	44,81±1,43	64,21±2,27*	62,81±0,93*
Urea, µmol/L	6,89±0,34	9,08±0,41*	8,73±0,45*
Glucose, µmol/L	5,84±0,25	12,91±0,63*	10,42±0,38*#
TBA s., a.u.	0,260±0,012	0,471±0,023*	0,418±0,019*#
TBA e., a.u.	0,501±0,027	0,680±,037*	0,632±0,034*
TBA ind., a.u.	0,608±0,033	0,997±0,053*	0,925±0,051*
CHEL, liver	0,283±0,004	0,376±0,010*	0,379±0,013*
CHEL, kidney	0,419±0,005	0,458±0,009*	0,422±0,005#
CHEL, heart	0,221±0,003	0,350±0,007*	0,297±0,004*#
FCHEL max, c.u.	1,993±0,065	3,452±0,113*	3,041±0,106*#
SCHEL, c.u.	2,597±0,086	5,176±0,171*	4,584±0,150*#
TAA, mg/L	1,030±0,034	0,685±0,022*	0,765±0,024*#
SH-group, µmol/g Hb	0,287±0,006	0,195±0,008*	0,203±0,004*
IEI, %	0,19±5,08	129,34±14,45*	94,25±12,27*
COMBer	0,08±0,71	15,51±1,09*	13,16±1,01*

Note: * - $p <0,05$ compared with group 1 (control); # - $p <0,05$ compared with indicator of group 2.
TBA s., a.u. - the amount of products that react with thiobarbituric acid in plasma, absorbance units;
TBA e., a.u. - basal quantity of the products react with thiobarbituric acid in erythrocytes, absorbance units;
TBA ind., a.u. - the amount of products of oxidative modification (Fe2 + -induced) in red blood cells, absorbance units;
CHEL – chemiluminescence;
FCHEL max, c.u. – flash chemiluminescence maximum, conventional units;
SCHEL, c.u. – square chemiluminescence, conventional units;
TAA, mg/L – total antioxidant activity;
IEI - index of endogenous intoxication;
COMBer - coefficient of oxidative modification of biomolecules erythrocytes;

Thus, the data characterizing the state of prooxidant-antioxidant system indicate the important role of the imbalance in its work during the development of metabolic disorders in rats with alloxan diabetes, including the formation of pathological changes in the organs of detoxification. This noted a corrective influence deuterium depleted water (40 ppm) on the state of prooxidant-antioxidant and detoxifying systems in rats with alloxan diabetes that allows to recommend the use of isotopic exchange reactions at complex correction of metabolic disorders related to insulin deficiency.

In general, the use of water in treatment with deuterium depleted water allowed to reduce intensity of abnormal operation of the antioxidant system, and reduce the intensity of free radical oxidation in the blood and tissues of internal organs, which was accompanied by less significant accumulation endotoxic substances in the blood plasma.