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Тұжырым

Экологиялық қауіпсіздік – қоршаған ортаның антропогенді немесе табиғи әсерлерінен қорғану үдерісі болып табылады. Заманауи өндірісте маңызды гигиеналық мәселеге қоршаған ортаның күйін экологиялық бақылау жатады, әлемдік экологиялық қауіпсіздік және экологиялық мәдениет бірінші жоспарға шығып, адамның өмірін, денсаулығын, амандығын қатерлерден сақтайды.

Summary

Ecological safety is the process of environment prevention from anthropogenic or natural factors. Ecological environment control is the important hygienic task; by this reason the conception of the global ecological safety and ecological culture is a principal things for resisting against threats to life, health and prosperity.

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BIOMECHANICAL AND BIOELECTRICAL PROPERTIES OF RAT'S BLOOD UNDER THE EFFECT OF INFRASOUND AT DIFFERENT DURATIONS OF TIME

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Abstract

Purpose: To study the effect of infrasound from 13 to 30 Hz with intensity range 10.9 to 14 dB on some biomechanical and bioelectrical properties of rat's blood.

Materials and Methods: 56 albino rats, each of average weight 200-250 g were exposed to different durations of time to infrasound waves in an infrasonic radiator with sound fluctuations from 13 to 30 Hz and with intensity 10.9 to 14 dB. The animals were divided into 8 groups according to periods of exposure to infrasound, the samples of blood collected from all animals before exposure as a control and after 3, 10, 30, 60, 180, 600, 1800, 3600 seconds of exposure for studying the erythrocytes membrane permeability and electrical conductivity of the blood.

Results: a significant decrease in the average hemolysis (H_{50}). High significant increase in rate of hemolysis, elasticity of red blood cell membrane and the maximum rate of hemolysis $(dH/dC)_{max,}$ while the electric conductivity showed very high significant increase at all periods of exposure except at 3600 seconds recorded no significant increase.

Conclusion: infrasound from 13 to 30 Hz with intensity range 10.9 to 14 dB can induce changes in the permeability of red blood cell membrane and bioelectric conductivity.

Key words: Infrasound; biomechanical; bioelectrical; rat's blood

Introduction

Recent attention has been drawn toward the potential, detrimental health outcome of infrasound (generally defined as inaudible sound with low frequency (0.0001–20 Hz) (1)With the rapid development of modern industry and transport, infrasound plays a more and more important role in the dramatic increase of noise pollution in our environment [2, 3]. The impact of infrasound on the individual and other environmental organisms has been studied insufficiently, but in most cases it is negative [4]. It's reported that Exposure to 8 Hz at 100 and 140 dB for up to 25

days affected conjunctival blood vessels, capillaries initially constricted and an increased permeability of blood vessels led to capillary and tissue swelling [5]. Health protection agency reported that some of the clinical features attributed Vibroacoustic diseases overlap with those claimed for electrical sensitivity and multiple chemical sensitivity [6]. Although there have been some studies on infrasonic toxicology, relative little is known about the adverse effects of infrasound on the properties of erythrocyte. Therefore the goal of this study is to evaluate the exposure effects of infrasound in frequencies from 13 to 30 Hertz with intensity in range 10.9 to 14 dB at different intervals of times exposure on some biomechanical and bioelectrical properties of rats erythrocytes.

Materials and Methods

In this work 56 albino rats, each of average weight 200-250 gm. Rats were kept under standard conditions along the experimental period, 12/12 h light-dark regimen. Food and water were supplied daily *ad libitum*. All animals were housed according to the ethic rules in compliance with institutional guidelines. Rats were exposed to infrasound in an infrasonic radiator EFC-1 with an exit of sound fluctuations from 13 to 30 Hz with intensity 10.9 to14 dB [7]. The animals were divided into 8 groups according to periods of exposure to infrasound. The samples of blood collected from all animals before exposure as a control and after 3, 10, 30, 60, 180, 600, 1800, 3600 seconds of exposure for studying the permeability of erythrocytes membrane permeability and electrical conductivity of the blood and results treated with SPSS program.

All data were expressed as mean ± SE and statistical analysis was made using the Statistical Package for Social Sciences (SPSS 11.0 software and Microsoft Excel 2010). For tests, analysis of differences between groups consisted on a one-way analysis of variance (ANOVA) with repeated measures, followed by post-hoc comparisons (LSD test). Differences were considered statistically significant at $p< 0.05$ and marked as (*), highly significant at $p< 0.01$ and marked as (**), and very highly significant at $p< 0.001$ and marked as (***).

This was measured by the degree of hemolysis in a mixture of isotonic solutions of urea and NaCl after an incubation of 3 min, the samples were centrifuged at 2500 r.p.m for 10 min, 4°C the optical density was measured by means of (UV- Vis- Spectrophotometer 303-PD) at 540 nm. The level of hemolysis was presented as the percentage of hemolysis caused by a 0.1% solution of Na2Co3 [8].

The hemolysis curve can be evaluated by the average hemolysis (H_{50}-the NaCl Concentration producing 50% hemolysis). The differentiation of the hemolysis curve will represent a Gaussian curve (the rate of hemolysis dH/dC versus NaCl concentration as shown in Figure 2). The parameters area, width, height and position of the peak can obtain from Gaussian curve. The area under curve represents the rate of hemolysis of red blood cells. The width at half maximum reflects the dispersion of hemolysis process (low dispersion than normal indicates sudden rupture of the RBCs, while higher values of dispersion reflects the abnormal increase in the membrane elasticity). The Gaussian peak represents the maximum rate of hemolysis (dH/dC) max reached by the sample. The position on the x-axis is equivalent to the average hemolysis (H_{50}) [9].

The electrical properties of RBCs can be investigated by measuring the electrical properties of blood suspension, which has the benefit of measuring viable cells close to its physiological state, and to avoid any induced changes in the sample during preparation or rouleaux formation during settling in the measuring tubes. The blood samples were diluted in isotonic buffered saline (pH 7.4 and conductivity 0.627 S/m), and the hematocrit was adjusted at 3%. The samples were incubated in water bath at 37°C during measurement. The electrical conductivity was determined by means of 32000 conductivity instrument ISTC Property K1117-15 [10].

Results and discussion

Figure 1 shows hemolysis curves at different concentration of NaCl (0.9%) for control and after different periods of exposure. The results show that the hemolysis curve for all groups shift to the left compared with control except two groups which exposed to 10 and 60 seconds. This indicates that significant decrease in the average hemolysis (H_{50}) as shown in table (1). Generally from the results it can be concluded a significant decrease in the average hemolysis (H_{50}), while a significant increase in the maximum rate of hemolysis $(dH/dC)_{max}$, area under the curve and the width at half maximum were shown (Table 1). Also the results of electric conductivity showed very highly significant increase in most periods of exposure as shown in figure 3 and table 2.

In the present study, we focused on the effects of infrasound from 13 to 30 Hz with intensity range 10.9 to 14 dB on permeability of membrane and the electric conductivity of blood. From investigation we found that exposure to infrasound increase the permeability of erythrocytes membrane as a result of increase of penetrating urea through a cellular membrane and create inside the erythrocyte a hyperosmotic medium, which leads to swelling of the erythrocyte, infringement of the integrity of the cell membrane and leakage of hemoglobin [8]. These results are in agreement with (11, 5, 12, 13, 14, and 15) and this may be due to increase of oxidative stress produced by the noise stress [16] and which in many studies showed that several parameters of red blood cells functions and integrity are negatively affected by increased oxidative stress which is responsible for hemolysis and induces the activation of an enzyme directly involved in energy metabolism whose regulation might closely be related to the maintenance of cell integrity [17] and which may be lead to changes of erythrocyte membrane ionic permeability [18].

The electrical properties of biological tissues and cell suspensions have been of interest for over a century for many reasons; they determine the pathways of current flow through the body and, thus, are very important in the analysis of a wide range of biomedical applications such as functional electrical stimulation and the diagnosis and treatment of various physiological conditions [19].

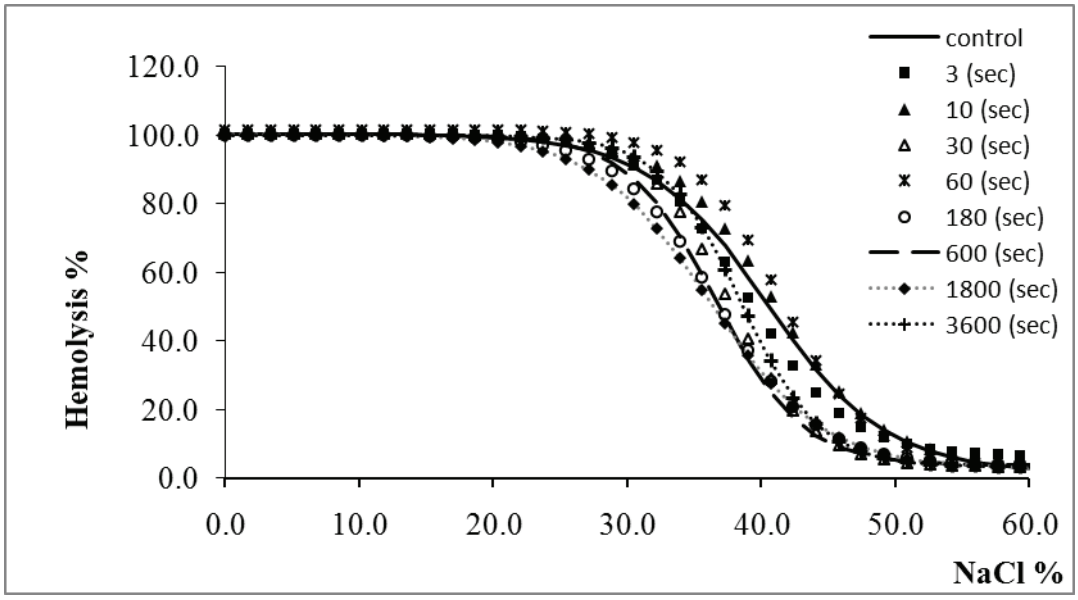

Figure 1 - Hemolysis curves at different concentrations percent of NaCl (0.9%) for control and after different periods of exposure

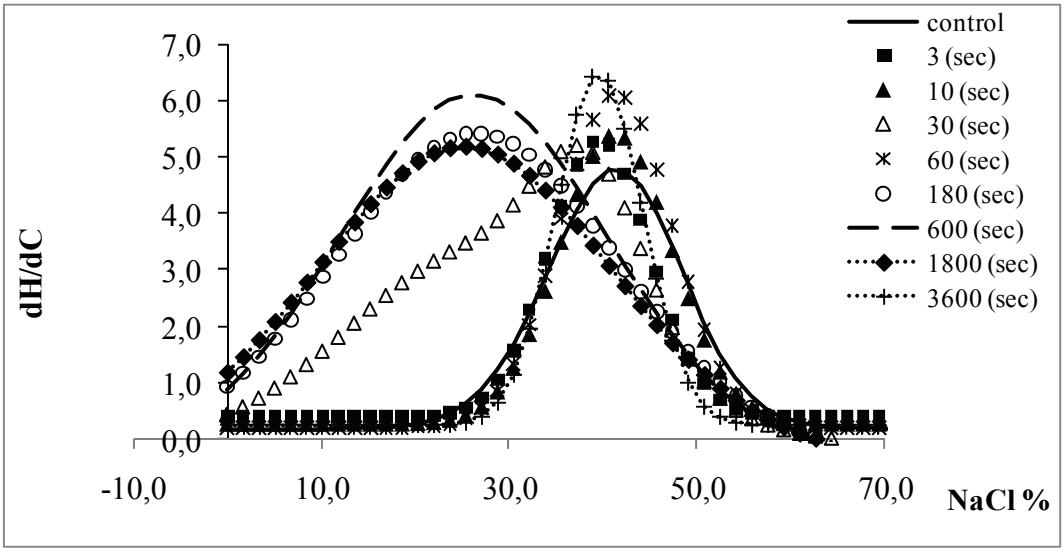

Figure 2 - The rate of hemolysis versus NaC l % for control and at different periods of exposure

Table 1 - The area (A), width (W), Height (H) and H_{50} of the Guassian peaks for control and after different periods of exposure

Irradiation time(Sec)	AREA(A) Mean ±SE	WIDTH(W) Mean ±SE	HEIGHT(H) Mean ±SE	H_{50} Mean ±SE
CONTROL	-83.0±4.9	14.4±1.3	-4.6±0.1	40.4±0.1
3.0	-66.7±4.2	10.8±0.7	-4.9±0.0	38.8±0.5*
10.0	-77.4±4.5	12.0±0.5	-5.1±0.1	40.8±0.5
30.0	-158.9±81.4	19.6±8.4	-6.2±0.7**	37.6±0.4***
60.0	-89.4±4.3	12.0±0.4	-5.9±0.1**	41.4±0.4
180.0	-215.0±4.9**	30.1±0.3**	-5.7±0.2*	36.7±0.5***
600.0	-228.7±6.6**	28.5±0.2**	-6.4±0.2***	36.6±0.4***
1800.0	-214.4±3.9**	31.2±90.4**	-5.5±0.2*	35.7±0.5***
3600.0	-72.6±1.8	9.3±0.2	-6.3±0.0*	38.4±0.4**
TOTAL	-134.0±17.2	18.6±2.2	-5.6±0.2	38.5±0.5
F- ratio	6.41	9.91	6.05	24.58
P-value	0.01**	0.00***	0.01**	0.00***
Where -*P≤0.05; **P ≤0.01;***P≤0.001				

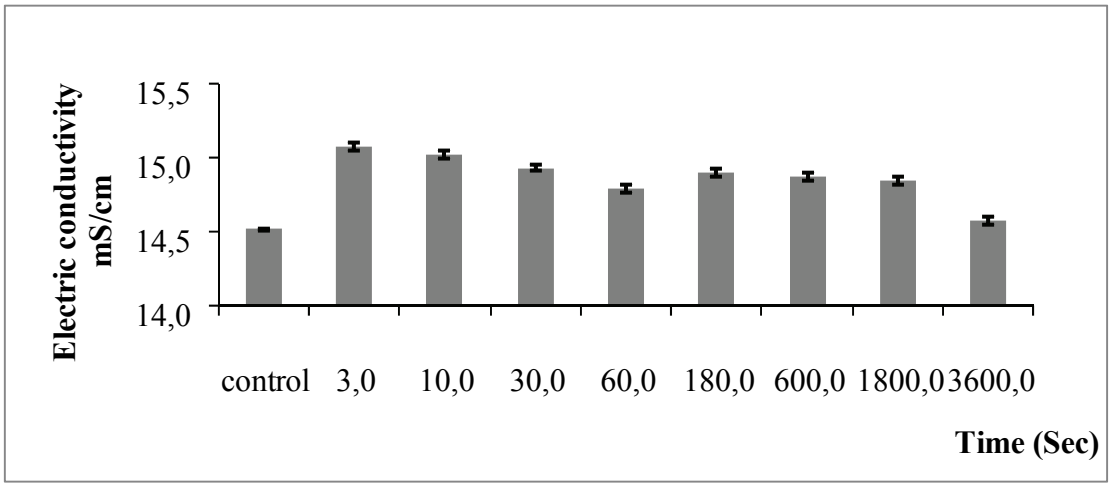

Figure 3- The electric conductivity (mS/cm) versus time (sec) for control and after different periods of Exposure

Table 2- The electric conductivity (mS/cm) for control and after different periods of exposure

	Electric Conductivity (mS/cm) at 1000Hz	
Irradiation time(S)	Mean ±SE	LSD
control	14.517±0.005	
3.0	15.075±0.025***	0.000
10.0	15.025±0.025***	0.000
30.0	14.935±0.025***	0.000
60.0	14.795±0.025***	0.000
180.0	14.905±0.025***	0.000
600.0	14.875±0.025***	0.000
1800.0	14.845±0.025***	0.000
3600.0	14.575±0.025	0.117
total	14.839±0.043	
One way ANOVA		
F- ratio	62.80	
P-value	0.00***	
Where -*P≤0.05; **P ≤0.01;***P≤0.001		

In our research it's shown that the electric conductivity of the groups treated by infrasound has higher values than the normal which indicates a large increase of the surface charge density of erythrocytes resulted from the formation of highly reactive species such as superoxide radicals (2 O−•), hydrogen peroxide (H2O2), hydroxyl radicals (•OH) and lipid peroxides (LPO) [20, 21]. This is in agreement with [22] who indicated that infrasonic exposure induced organismal effect suggests that infrasound is capable of eliciting certain biological resonance responsible for a series of physical and chemical consequences. Based on the results of study and in the light of bio resonance phenomena it is believed that the mechanical energy of infrasound was absorbed and turned into thermal, biochemical and bioelectrical energy, which can directly affect the plasma membrane and mitochondrial membrane of various tissues and cells, result in a change in membrane permeability as well as affect enzyme activity. Thus, the resonant mechanical energy will finally affect the bio-oxidation process as well as the metabolism and synthesis of the energy and reduce the function of the anti-oxidation system [23].

In a word, the exposure to infrasound from 13 to 30 Hz with intensity 10.9 to 14 dB possesses the potentials to induce hazardous biological effects in rats. The main damaging role of exposure to infrasound may be cellular membrane represented by change in the permeability of red blood cells and the electric conductivity. Further more and more studies are required for the final conclusion on the mechanism of infrasound influence on the blood cells.

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Тұжырым

Жұмыста 10,9-14 дБ диапазонында қарқындылығы болатын 13-30 Гц аралығындағы инфрадыбыстың мембрана өткізгіштігіне және қанның электрлік өткізгіштігіне әсері зерттелген. Эритроциттер мембранасының сипаттары (өткізгіштігі, беткейлік заряд өзгерісі, ферменттердің белсенділігі т.б.) өзгеретіні анықталды. Инфрадыбыс энергиясының тасымалдау механизмдерінің мүмкіндіктері, резонанстың биототығу процестерін өзгертетіні, заттардың алмасуы мен синтезделуі және анти-тотығу жүйесінің функциясы төмендейтіні қарастырылады.

Резюме

В работе исследовано последствие инфразвука от 13 до 30 Гц с интенсивностью диапазоне 10,9 до 14 дБ на проницаемость мембраны и электрической проводимости крови. Установлено, что при этом меняются характеристики мембраны эритроцитов (проницаемость, изменение поверхностного заряда, активность ферментов и т.д.). Обсуждается возможный механизм трансформации энергии инфразвука и за счет резонанса приводящее к изменению процессов биоокисления, обмена и синтеза веществ и снижению функции системы анти-окисления.