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EFFECT OF HYPOTHALAMIC PREOPTIC NUCLEUS ELECTRICAL ACTIVITY CHANGES ON GONADAL HORMONE REGULATION IN NORMAL AND EXTREME STATES

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With the purpose to examine the changes in the activity of gonadal hormones resulting from the effects of hydrogen sulfide gas and electrode implantation on the preoptic nucleus of the hypothalamus 35 female rabbits were observed. The activity of follicle-stimulating hormone, luteinizing hormone, and estradiol in the blood were evaluated after stress. On the 5th day follicle-stimulating hormone decreased by 0.26 IU/l; luteinizing hormone decreased by 0.18 IU/l, estradiol increased by 207.4 pg/ml ($P<0.001$) from the normal value. In the post-model period, electroencepfalografic waves and hormones do not return to normal levels. On the 30th day of gas exposure, follicle-stimulating hormone, luteinizing hormone, and estradiol decreased significantly ($P<0.001$). Thus, the preoptic nucleus of the hypothalamus has a complex structure that plays a key role in the regulation of the biological functions of the body and occupies an essential place in the endocrine regulation of the pituitary-gonadal system.

Key words: hypothalamus, preoptic nucleus, hormone, hydrogen sulfide, toxic and mechanical stress.

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ВПЛИВ ЗМІН ЕЛЕКТРИЧНОЇ АКТИВНОСТІ ПРЕОПТИЧНОГО ЯДРА ГІПОТАЛАМУСА НА РЕГУЛЯЦІЮ СТАТЕВИХ ГОРМОНІВ У НОРМІ ТА В ЕКСТРЕМАЛЬНИХ СТАНАХ

З метою вивчення змін активності статевих гормонів, зумовлених впливом сірководню та імплантацією електродів у преоптичне ядро гіпоталамуса, було проведено спостереження за 35 самками кроликів. Після стресу оцінювали активність фолікулостимулюючого гормону, лютеїнізуючого гормону та естрадіолу в крові. На 5-у добу рівень фолікулостимулюючого гормону знизився на 0,26 МО/л, лютеїнізуючого гормону – на 0,18 МО/л, естрадіолу – збільшився на 207,4 пг/мл ($P<0{,}001$) від норми. У постмодельний період електроенцефалограма і рівень гормонів не поверталися до норми. На 30-й день газового впливу рівні фолікулостимулюючого гормону, лютеїнізуючого гормону і естрадіолу достовірно знизилися ($P<0{,}001$). Таким чином, преоптичне ядро гіпоталамуса має складну структуру, відіграє ключову роль у регуляції біологічних функцій організму і займає важливе місце в ендокринній регуляції гіпофізарно-гонадної системи.

Ключові слова: гіпоталамус, преоптичне ядро, гормон, сірководень, токсичний і механічний вплив.

From the perspective of modern directions of neurophysiology and neuroendocrinology, the investigation of the role of the integrative activity of the hypothalamus and the study of the mechanism of interaction between the hypothalamic-pituitary-gonadal system in various functional states of the organism remains one of the most pressing issues for the science of physiology. Thus, in extreme situations, the manifestation of stress reactions occurs with the participation of the integrative centers of the hypothalamus [6]. Since these centers regulate homeostatic processes and adaptive reactions, it is important to study the neurohormonal relationships of the organism in extreme situations of various origins. However, in the modern globalized world, the interaction between the monoaminergic functional activity of the organism and the neuroendocrine system, as well as the neurophysiological mechanisms underlying this relationship, remains insufficiently studied [1, 6, 11].

On the other hand, when harmful environmental substances enter the body in inadequate quantities, they not only cause the development of serious functional disorders, but also have a significant negative impact on human health [7, 10, 11]. Research into the mechanisms of functional regulation of the hypothalamus and alterations in endocrine hormone activity is highly relevant to mitigating the negative effects of these factors [8, 9, 13].

The negative effects of most harmful substances on the body occur either as a result of direct damage to the endocrine glands or indirect disruption of the functions of the endocrine system [4, 7]. On the other hand, in the modern globalized world, many extreme factors have a negative impact on most functions of the body [2, 3]. Proper assessment of such factors can play an important role in predicting and preventing negative effects on human health. Therefore, we considered it necessary to conduct research on the pathogenesis of the interaction of the neurohormonal mechanisms of the body under toxic stress conditions.

The purpose of the study was to investigate the role of the preoptic nucleus of the hypothalamus in regulating the activity of hormones of gonadal system under conditions of toxic stress induced by hydrogen sulfide gas and during the mechanical impact of electrode insertion.

Materials and methods. The research work was carried out at the Scientific Research Center of AMU and the Department of Normal Physiology in the period of 2022–2023.

The experimental study was conducted on 35 clinically healthy adult female outbred rabbits aged 6–8 months with a body weight of 2.5±0.5 kg. The animals were obtained from a certified breeding facility and were confirmed to be free of infectious and parasitic diseases by veterinary inspection prior to inclusion in the experiment.

Rabbits were housed in the certified vivarium of the Azerbaijan Medical University under standard laboratory conditions in individual stainless-steel cages (80×60×50 cm) with free access to water. The animals were maintained under a controlled environment with a temperature of 20–22 °C, relative humidity of 50–60 %, and a 12:12-hour light–dark cycle (lights on at 07:00, off at 19:00). Bedding was changed daily, and cages were disinfected regularly according to institutional biosafety regulations. The diet consisted of a standard pelleted laboratory rabbit feed supplemented with fresh vegetables (carrots, cabbage leaves) and hay. Water was provided ad libitum through automatic drinking systems. Feeding was performed twice daily at fixed times. All animals were acclimatized to the housing conditions for 3–4 days prior to the start of the experimental procedures.

The number of animals, sex and weight were selected according to certain factors described below.

The use of adult female rabbits was chosen to minimize variability associated with aggressive behavior, hormonal fluctuations typical for males, and body weight heterogeneity, thereby improving the reproducibility and reliability of the experimental results. The selected weight range (2.5±0.5 kg) corresponds to fully mature rabbits with stable neuroendocrine regulation, which is critical for studies involving hypothalamic structures. The sample size of 35 animals was determined based on previous experimental studies of hypothalamic stimulation models, which demonstrate that this number provides sufficient statistical power to detect physiologically significant differences between experimental conditions while complying with the principles of the 3Rs (Replacement, Reduction, Refinement) to avoid unnecessary use of animals.

Before starting the experiment, electrodes were inserted into the preoptic nucleus of the hypothalamus, and the studies were conducted on the 7 groups shown below: rabbits of 1st group were in an intact (normal) state; animals in the 2nd, 3rd and 4th groups were exposed to toxic stress by giving hydrogen sulfide gas at a dose of 120 PPM in a special chamber for 30 minutes every day for 5 (2nd), 15 (3rd) and 30 days (4th) accordingly. 5th, 6th and 7th groups were released for 5, 15, and 30 days after creating a toxic stress model for 5, 15 and 30 days, respectively.

The mechanical effect of electrode insertion was also studied in each group. The frequency and amplitude of electroencephalographic (EEG) waves of the hypothalamus preoptic nucleus during the toxic stress model and post-model period in rabbits were recorded using the "Neuro-spectrum-2" EEG device. The concentrations of follicle-stimulating hormone (FSH), luteinizing hormone (LH), and estradiol (E2) in blood serum were determined by sandwich enzyme-linked immunosorbent assay (ELISA) using the Elisys Uno immunoassay analyzer (Germany). Commercial kits were used: DEF-a1 kits (USCN, China) and Endotoxin (ET) ELISA Kit (Abbexa, UK). All procedures were performed strictly according to the manufacturers' protocols.

All experimental procedures were conducted in strict accordance with the principles of the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (ETS No. 123, Strasbourg, 1986) and complied with the ARRIVE guidelines. All surgical interventions, including stereotactic implantation of electrodes into the preoptic nucleus of the hypothalamus, were performed under general anesthesia. Rabbits were anesthetized by intramuscular administration of ketamine hydrochloride (35 mg/kg) in combination with xylazine hydrochloride (5 mg/kg). Adequate depth of anesthesia was confirmed by the absence of corneal and pedal withdrawal reflexes. During surgical procedures, body temperature was maintained using a thermostatically controlled heating pad. Postoperative analgesia was provided by intramuscular injection of meloxicam (0.2 mg/kg once daily for 2 days). Animals were monitored daily for general condition, food and water intake, body weight, and signs of pain or distress throughout the experimental period.

Statistical analysis of the results of the study was carried out using the Microsoft Excel 2016 electronic program. Data were first assessed for normality of distribution using the Shapiro–Wilk test. Quantitative variables are presented as mean (M)±standard error of the mean (m), minimal (Min) and maximal (Max) values. Intergroup comparisons were carried out using Student's t-test for independent samples. Differences were considered statistically significant at $p<0.05$.

Results of the study and their discussion. The results of the study show that the amplitude and frequency rhythms of EEG waves in the preoptic nucleus of the hypothalamus change in a different nature and direction compared to the norm due to the toxic stress effect created by hydrogen sulfide gas. The strength of the rhythms of the waves deepens even more when toxic stress is applied for a month. No normalization of the EEG wave indicators is observed in the post-model period. Toxicity has both an activating and a depressant effect on the amplitude and frequency rhythms of EEG waves. Since this effect disrupts the mechanism of interaction between the preoptic nucleus of the hypothalamus and other systems, the activity of gonadal hormones in the blood changes.

Table 1

Effect of toxic stress, post-stress period, and mechanical effect of electrode insertion into the preoptic nucleus of the hypothalamus on the concentration of gonadal hormones in the blood, created by 5th and 15th days of hydrogen sulfide gas administration

Hormonal and statistical indicators		Experiment days									
		The norm		Mechanical effect		5 days of sulfur dioxide exposure		Mechanical effect		After 5 days of exposure to sulfur dioxide, 5 days of release	
		Abs, ng/ml	%	Abs, ng/ml	%	Abs, ng/ml	%	Abs, ng/ml	%	Abs, ng/ml	%
FSH, IU/l	M	1.00	100.0	0.94	94.0	0.74	74.0	0.95	95.0	0.92	92.0
	± m	±0.07		±0.11*		±0.03**		±0.09*		±0.15*	
	Min	0.8		0.63		0.69		0.66		0.7	
	Max	1.2		1.3		0.82		1.2		1.5	
LH, IU/	M	2.04	100.0	2.00	98.2	1.86	91.1	2.07	101.4	1.90	93.1
	± m	±0.09		±0.13 *		±0.11***		±0.17*		±0.04***	
	Min	1.8		1.7		1.6		1.75		1.8	
	Max	2.3		2.4		2.2		2.65		2.0	
E2, pg/ml	M	314.0	100.0	328.3	104.6	106.6	339.5	318.4	101.4	140.3	446.8
	± m	±13.6		±11.0 *		±4.0 ***		±8.16 *		±4.1 ***	
	Min	272.0		290.5		99.6		299.5		125.6	
	Max	353.6		351.4		120.4		340.2		150.4	
		The norm		Mechanical effect		15 days of sulfur dioxide exposure		Mechanical effect		After15 days of exposure of sulfur dioxide, 15 days of release	
FSH, IU/l	M	1.00	100.0	*0.91	91.0	***0.62	62.0	*0.88	88.0	***1.10	110.0
	± m	±0.07		±0.05		±0.04		±0.05		±0.09	
	Min	0.8		0.71		0.5		0.71		0.9	
	Max	1.2		1.0		0.72		1.02		1.4	
LH, IU/l	M	2.04	100.0	*1.88	92.2	*2.08	102.0	*1.86	91.2	*2.16	105.9
	± m	±0.09		±0.09		±0.25		±0.07		±0.17	
	Min	1.8		1.6		1.5		1.7		1.8	
	Max	2.3		2.1		2.8		2.1		2.8	
E2, pg/ml	M	314.0	100.0	*331.5	105.6	***102.9	327.7	*331.7	105.6	***168.2	535.7
	± m	±13.6		±9.1		±6.4		±6.4		±1.0	
	Min	272.0		310.2		80.9		320.4		165.4	
	Max	353.6		355.4		115.6		348.3		170.3	

Note: Abs – absolute value; reliability compared to the norm - * – P >0.05; **$P_1<0.05$; *** $P_2<0.001$.

On the 5th day of the stress model, the absolute value of FSH in the blood compared to the normal state decreases by 0.26 IU/l, P<0.001, and the relative value by 36.0 %. Slightly different results are obtained from the mechanical effect of the electrode insertion into the preoptic nucleus. Its absolute value decreases by 0.06 IU/l, P>0.05, and its relative value decreases by 6.0 %. After creating a stress model for 5 days, the absolute value of FSH in the group released for 5 days decreases insignificantly by 0.08 IU/l, and its relative value by 8.0%. In this group, after mechanical effect, the absolute and relative values of FSH in the blood (5 %) practically remain at the level of the previous group.

Slightly different results are obtained in the activity of another adenohypophyseal hormone in the blood. Thus, on the 5th day of stress, the absolute value of LH in the blood compared to the normal state decreases by 0.18 IU/l, P<0.00, and the relative value by 8.9 %.

However, due to the mechanical effect of the electrode insertion into the preoptic nucleus, the absolute value of LH in the blood decreases by only 0.04 IU/l, P>0.05, and the relative value by 1.8 %. In the group released 5 days after the stress model, the absolute value of LH in the blood significantly decreased by 0.14 IU/l, P<0.00, and the relative value by 6.9 %. In this group, the absolute and relative values of LH after the electrode insertion practically did not differ from the level in the previous group.

On the 5th day of gas exposure, the absolute value of E2 in the blood increased by 207.4 pg/ml, P_2<0.001, and the relative value by 239.5 % (more than 3 times) from the normal. Due to the mechanical effect of the electrode insertion into the preoptic nucleus, the absolute value of E2 increased by 14.3 pg/ml, P>0.05, and the relative value by 4.6 %. In the group released for 5 days after creating a stress model, the absolute value of E2 in the blood significantly decreased by 163.7 pg/ml P_2<0.001, and the relative value by 346.8 % (more than 4 times). In this group, the absolute and relative values of E2 in the blood were practically at the level of the previous group.

After the 15th day of toxic stress, the absolute value of FSH in the blood continued to decrease, its decrease was 0.38 IU/l, P<0.001 (38.0 %). Slightly different results were obtained from mechanical exposure (absolute value 0.09 IU/l, P>0.05, relative value decreased by 9.0 %) (Table 1).

After creating a 15-day stress model, the absolute value of FSH in the blood of the released group for 15 days significantly increased by 0.1 IU/l, and the relative value by 11.0 %, (p<0.001). However, after mechanical exposure, the absolute value of FSH in the blood decreased to 0.18 IU/l (P>0.05), and the relative value by 12.0% (p<0.001).

After the 15th day of toxic stress, the absolute and relative values of LH in the blood decreased slightly to 0.04 IU/l (P>0.05, 4.0 %). However, after mechanical exposure, the absolute value of LH decreased by 0.16 IU/l (P>0.05), and the relative value by 7.8 %. After creating a 15-day stress model, the absolute value of LH in the blood of the released group for 15 days significantly increased by 0.12 IU/l, and the relative value by 5.9 % (p<0.001). However, after the mechanical effect of the electrode insertion into the preoptic nucleus, the absolute value of LH in the blood decreased to 0.18 IU/l (P>0.05), and the relative value by 8.8 % (p>0.05)

On the 15th day of exposure to hydrogen sulfide gas, the amount of E2 in the blood significantly decreased by 211.1 pg/ml (227.7 %, P<0.001) from the norm. However, after mechanical exposure, the amount of E2 in the blood increased and amounted to 17.5 pg/ml, P>0.05 (5.6 %). After creating a stress model for 15 days, the absolute value of E2 in the blood of the released group for 15 days significantly decreased by 145.7 pg/ml, P_2<0.001, and the relative value decreased by 435.7 %. In this group, the absolute and relative values of E2 in the blood after mechanical exposure were practically at the level of the previous group.

On the 30th day of gas exposure, the decrease in the amount of FSH in the blood continued and became even more pronounced. Thus, the absolute value of its decrease under the influence of the stress model was significantly 0.62 IU/l, P<0.001. The relative value of such a decrease in its amount was 62.0 %, P<0.001. After mechanical exposure, the absolute value of FSH in the blood decreased to 0.1 IU/l, P>0.05, and the relative value was 10.0%. In the released group for 30 days after the 1-month stress model, the absolute value of FSH in the blood significantly decreased to 0.32 IU/l, and the relative value was 32.0 %, (p<0.05). However, after mechanical impact, the absolute value of FSH in the blood decreased to 0.14 IU/l, P>0.05, while the relative value was only 14.0 %, (p>0.05) (Table 2).

On the 30th day of the experiment, the absolute value of the decrease in the amount of LH in the blood due to stress was significantly 1.48 IU/l, and the relative value of such a decrease in its amount compared to the norm was 71.6 %, P<0.001. After the mechanical effect of the electrode insertion into the preoptic nucleus, the absolute and relative value of LH in the blood decreased by 0.06 IU/l, P>0.05, 2.9 %. After creating a 30-day stress model, the absolute value of LH in the blood of the released group for 30 days significantly increased by 0.48 IU/l, and its relative value increased by 23.5 %, (p<0.05). After the mechanical effect, the absolute value of LH in the blood decreased by 0.1 IU/l, P>0.05, and its relative value was 4.9 %, (p>0.05).

Table 2

Effect of toxic stress, post-stress period, and mechanical effect of electrode insertion into the preoptic nucleus of the hypothalamus on the concentration of gonadal hormones in the blood, created by 30 days of hydrogen sulfide gas application

Hormonal and statistical indicators		Experiment days									
		The norm		Mechanical effect		30 days of sulfur dioxide exposure		Mechanical effect		After 30 days of exposure to sulfur dioxide, 30 days of release	
		Abs, ng/ml	%	Abs, ng/ml	%	Abs, ng/ml	%	Abs, ng/ml	%	Abs, ng/ml	%
FSH, IU/l	M	1.00	100.0	*0.90	90.0	***0.38	38.0	*0.86	86.0	***0.68	68.0
	± m	±0.07		±0.08		±0.07		±0.07		±0.07	
	Min	0.8		0.65		0.2		0.7		0.4	
	Max	1.2		1.1		0.6		1.1		0.8	
LH, IU/	M	2.04	100.0	*1.98	97.1	***0.58	28.4	*1.94	95.1	**1.56	76.5
	± m	±0.09		±0.12		±0.09		±0.10		±0.16	
	Min	1.8		1.7		0.4		1.7		1.1	
	Max	2.3		2.3		0.9		2.2		2.0	
E2, pg/ml	M	314.0	100.0	*333.4	106.2	***199.0	63.4	*326.9	104.1	***276.5	88.1
	± m	±13.6		±8.2		±4.8		±9.6		±10.2	
	Min	272.0		315.4		188.5		304.4		240.9	
	Max	353.6		361.2		215.5		249.4		32.5	

Note: Abs – absolute value; Reliability compared to the norm – P* >0.05; reliability compared to the norm **P_1 <0.05; reliability compared to the norm *** P_2<0.001.

On the 30th day of toxicity, the absolute value of E2 in the blood was significantly lower than the norm by 115.0 pg/ml, and the relative value was 36.5 % (P<0.001). However, after mechanical exposure, the absolute value of E2 in the blood increased to 19.4 pg/ml, P>0.05, and the relative value was 6.2 %. After the 30-day stress model of hydrogen sulfide gas was created, the absolute value of E2 in the blood in the released group for 30 days was 37.5 pg/ml P_2<0.001, and the relative value was 11.9 %. In this group, the absolute and relative values of E2 in the blood after mechanical exposure were practically at the level of the previous group (increased by 4.1 %).

The strength of the EEG wave rhythms in the preoptic nucleus of the hypothalamus changes in different directions due to the toxic effect of hydrogen sulfide gas and the mechanical effect of the electrode. The application of toxic stress for a month further deepens the strength of the wave rhythms. In the post-model period, the EEG waves do not normalize. Slightly different results are obtained from the mechanical effect of the electrode insertion into the preoptic nucleus. Toxicity has both an activating and a depressant effect on the strength of the EEG waves. Along with all this, the effect of toxic stress changes the activity of adenohypophyseal sex hormones in different directions and in a wave-like manner.

Thus, due to such changes occurring in the nervous system during the period of toxic stress, the activity of gonadal system hormones (FSH, LH and E2) in the blood changes. In the post-model period, the amount of hormones in the released animals does not normalize. These results indicate that the hypothalamus' mechanism for regulating the hormones of the gonadal system is disrupted, resulting in changes in the synthesis and secretion of hormones.

Numerous articles have been published on the topic of impact of stress factors on nervous system in mammals [5, 11, 12].

Walker DM, et al (2016) noted that steroid hormones acting on the hypothalamus during critical periods of development play a crucial role in the functioning of many bodily systems. In their review, the authors describe the potential role of epigenetic processes, particularly DNA methylation, in the hormonal regulation of hypothalamic sexual differentiation. The authors examined the disruption of these processes by endocrine disruptors (EDCs) across age, sex, and region, focusing on how perinatal EDCs act via epigenetic mechanisms to reprogram DNA methylation and sex steroid receptor expression throughout life [12].

In our work, even after the mechanical effect of the electrode insertion into the preoptic nucleus, the amount of gonadal system hormones in the blood differs from the norm. In the post-model period, the amount of hormones in the released animals did not normalize.

These results prove that since the monoaminergic and peptidergic systems of the hypothalamus disrupt the regulatory function of hormone-synthesizing cells in the adenohypophysis and gonads, the synthesis of hormones and their secretion into the blood are altered. Therefore, the toxic stress created by hydrogen sulfide gas and the mechanical stress created by the electrode insertion on the preoptic nucleus of the hypothalamus change the activity of gonadal hormones in the blood [6, 13].

Some authors studied the response of rats to electrical stimulation of the neural lobe (NL) of the pituitary after an anterolateral incision around the medial basal hypothalamus (MBH). The rats did not respond with ACTH release; the number of nerve fibers and terminals in the NL decreased to less than 5 % of normal. After damage to the paraventricular nuclei, NL stimulation caused an increase in plasma corticosterone levels, which was significantly lower than in the control group. These results suggest that the NL contains electrically excitable fibers capable of releasing corticotropin-releasing factor, and that these fibers likely originate outside the MBH [5].

Considering the regulatory interaction between leptin and the hypothalamic–pituitary–gonadal (HPG) axis, the study of Solhjou KA, et al (2019) aimed to assess alterations in leptin and HPG axis hormones in adult male rats exposed to the insecticides Proteus and Biscaya. A total of 110 adult male Wistar rats (80–90 days old, average weight 200–210 g) were used. The animals received intraperitoneal injections of the insecticides for 14 consecutive days. At the end of the experiment, blood samples were collected to determine serum concentrations of LH, FSH, gonadotropin-releasing hormone, testosterone, and leptin. Comparative analysis between control and experimental groups (treated with average and maximum doses of both insecticides) revealed a significant, dose-dependent decrease in mean serum levels of FSH (P=0.001), LH (P=0.001), gonadotropin-releasing hormone (P=0.001), testosterone (P=0.005), and leptin (P=0.001). These findings suggest that exposure to Proteus and Biscaya leads to a dose-dependent suppression of leptin, resulting in reduced secretion of GnRH, LH, FSH, and testosterone [11]. In our work we assessed FSH, LH, E2 in the blood and also revealed significant changes after exposure of sulfur dioxide.

However, slightly different results were obtained from the effect of mechanical stress. The activity of hormones in the blood also deviates from the norm after the mechanical effect of the electrode insertion into the nucleus. Slightly different results are obtained from the effect of mechanical stress. The results show that there is a high positive correlation between FSH, LH and E2 due to the change in the activity of the preoptic nucleus of the hypothalamus under toxic conditions.

Conclusions

1. On the 5th day of the stress model, FSH in the blood decreased by 0.26 IU/l (36.0 %; P<0.001); LH decreased by 0.18 IU/l (8.9 %; P<0.001), E2 increased by 207.4 pg/ml (239.5 %; P<0.001) from the normal value.

2. After creating a 15-day stress model, FSH increased by 0.1 IU/l (11.0 %; P<0.001); LH decreased to 0.04 IU/l (4.0 %; P>0.05), E2 decreased by 211.1 pg/ml (227.7 %; P<0.001) from the normal value.

3. On the 30th day of gas exposure, FSH decreased significantly to 0.62 IU/l (62.0 %; P<0.001); LH decreased significantly to 1.48 IU/l (71.6 %; P<0.001); E2 was significantly lower than the norm by 115.0 pg/ml (36.5 %; P<0.001).

Thus, the preoptic nucleus of the hypothalamus has a complex structure that plays a key role in the regulation of the biological functions of the body and occupies an essential place in the endocrine regulation of the pituitary-gonadal system.

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INFLUENCE OF A COMPLEX OF FOOD SUPPLEMENTS ON THE CONDITION OF RETINAL NEURONS IN RATS

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The paper presents data from a morphometric study of the diameter of neurocyte nuclei in the outer nuclear, inner nuclear, and ganglion layers of the retina under the combined action of food additives. It has been established that the effect of a complex of dietary supplements – sodium glutamate, sodium nitrite, and Ponceau 4R – causes a progressive decrease in the average diameter of retinal nerve cell nuclei due to a decrease in euchromatin volume, which indicates a decrease in cell activity. The combined effect of food additives leads to the development of oxidative stress, to which proteins, lipids, and DNA respond, the development of nonspecific inflammation, structural degradation, and the development of gliosis in response to damage. Thus, monosodium glutamate, sodium nitrite, and Ponceau 4R affect the function of the visual analyzer, primarily causing deterioration and once again confirming the need for strict quality control of domestic and foreign products.

Key words: food additives, monosodium glutamate, sodium nitrite, Ponceau 4R, retina, eye, oxidative stress, rats.

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ВПЛИВ КОМПЛЕКСУ ХАРЧОВИХ ДОБАВОК НА СТАН НЕЙРОЦИТІВ СІТКІВКИ ОКА ЩУРІВ

В роботі представлені дані морфометричного дослідження діаметру ядер нейроцитів зовнішнього ядерного, внутрішнього ядерного та гангліонарного шарів сітківки при комплексній дії харчових добавок. Встановлено, що вплив комплексу харчових добавок – глутамату натрію, нітриту натрію та Понсо 4R, викликає прогресивне зменшення середніх значень діаметру ядер нервових клітин сітківки, внаслідок зменшенням об'єму еухроматину, що свідчить про зменшення активності клітин. Комплексна дія харчових добавок призводить до розвитку оксидативного стресу, на що реагують білки, ліпіди та ДНК, розвитку неспецифічного запалення, структурної деградації та розвитку гліозу у відповідь на пошкодження. Отже, глутамат натрію, нітрит натрію та Понсо 4R впливає на функцію зорового аналізатору, насамперед, викликаючі погіршення та в черговий раз підтверджує необхідність суворого контролю за якістю вітчизняної та закордонної продукції.

Ключові слова: харчові добавки, глутамат натрію, нітрит натрію, Понсо 4R, сітківка, око, окислювальний стрес, щури.

The study is a fragment of the research project "Restructuring of the organs of the immune, respiratory, and excretory systems under the effect of various exogenous factors (monosodium glutamate, sodium nitrite, ethanol, methacrylate)", state registration No. 0121U108234

Recently, the use of food additives has spread to almost all stages of food production. In order to conceal poor-quality raw materials and make products look attractive, manufacturers add them, sometimes without complying with the standards established by Ukrainian legislation. The available literature often reports on the link between certain food additives and the development of cancerous tumors, allergies, and other adverse effects. However, it is important to recognize that the effect of any chemical substance on the human body depends on several factors, including personal characteristics, the amount of the substance, and the duration of exposure [5].

Previous studies have revealed the effect of food additives on organs and tissues separately from each other. However, an analysis of the content of domestic and foreign products revealed the addition of food additives in combination [12]. Therefore, the impact of food additives, especially when they act in combination, is currently very relevant and requires further research [14].