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# THE ACID-BASE PROCESSES' CHANGES IN THE BODY OF WHITE RATS UNDER THE INFLUENCE OF NITROGEN-CONTAINING SURFACE-ACTIVE MATERIAL

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**Relevance.** Everyday contact of the population with surfactants (SAS) in drinking water poses the problem of timely and prompt substantiation of pre-nosological highly sensitive indicators of early manifestations of biological activity of detergents and operational control over the health of the population and the environment. But today the mechanisms of biotransformation, toxicodynamics, toxicokinetics and metabolic processes that underlie the formation of structural and metabolic disorders when exposed to a surfactant, taking into account possible long-term effects, have not yet been fully elucidated.

**Objective:** to investigate the effect of nitrogen-containing surfactants on redox processes in the body of experimental animals.

**Materials and methods.** The experiments were carried out on 620, and acute experiments on 128 white rats (weight 180-220 g). We used four ionic nitrogen-containing surfactants with specified technical and physicochemical characteristics: FOM 9, FOM 9-4, FOM 9-12 and FOM 9-20. Doses were chosen so as to determine the lethal effect in the lethal dose (LD) range from 0 to 100. The LD50 was calculated. The substances were introduced into the stomach in pure form using a metal probe. The animals were observed for up to 15 days. The time of death of the animals and the total amount of the introduced substance were recorded. The animals were subjected to postmortem examination. Redox processes were qualitatively assessed by the activity of enzymes: cholinesterase, cerulose plasmin, lactate dehydrogenase, malate dehydrogenase, succinate dehydrogenase, peroxidase, catalase, cytochrome oxidase, by the content of SH-groups in the blood, by the concentration of biogenic monoamines.

**Results.** Nitrogen-containing surfactants caused a change in peroxidase activity both upwards and downwards. In all cases, 1/1000 LD50 was inactive. On the 15th day of the experiment, neonol FOM 9-12 reduced the activity of the enzyme, and other substances did not affect it. By the end of the subacute experiment, neonol FOM 9-4 and neonol FOM 9-12 were reduced, and neonol FOM 9-20 increased peroxidase activity. A similar effect was on the activity of catalase: in all groups, except 1/1000 LD50, on day 30 there was a decrease in its activity. Cholinesterase activity increased. For the content of SH-groups in the blood on the 15th day there was a tendency to decrease, which turned into significant differences on the 30th day in 1/10 LD50. The effect of 1/100 and 1/1000 LD50 did not violate the content of SH-blood groups. A similar effect was on the content of glutathione in the blood. In a subacute experiment, in groups 1/10 and 1/100 LD50, the content of norepinephrine, tryptophan, serotonin in the liver increased and DOPA and dopamine decreased. The dynamics of adrenaline did not change. The content of dopamine and norepinephrine increased to a lesser extent in the brain; DOPA and adrenaline did not differ from the control; tryptophan increased only under the influence of FOM-9. 1/1000 LD50 did not affect the dynamics of the content of biogenic monoamines. The tested drugs have a similar effect on the body.

**Conclusions.** A more toxic substance in a subacute experiment is FOM-9. The severity of violations in the dynamics of monitoring the activity of enzymes has a close dose dependence. The effective dose is set at 1/10, the threshold – 1/100 and the inactive – 1/1000 LD50. Common features of the biological action of nitrogen-containing surfactants are the violation of redox processes, bioenergy, oxidative phosphorylation, which under appropriate conditions lead to the pathology of vital organs, functions and systems of the body.

**Key words:** nitrogen-containing surfactants, oxidation-reduction processes, biological action, dose dependence.

**Relevance.** The problem of protecting centralized surface sources of drinking water supply from pollution with surface-active substances (SAS) has acquired particular relevance today in Ukraine and requires scientific substantiation and the development of new, more stringent approaches to methods for assessing the sanitary and ecological situation in the basins of these reservoirs, as well as the introduction of effective ecological hygienic measures to protect both water sources and public health.

Everyday contact of the population with psychoactive substances poses the task of timely and operational substantiation of pre-nosological highly sensitive indicators of early manifestations of biological activity of detergents and operational monitoring of the health of the population and the environment for physicians and biologists. The solution of these issues requires a deep study of the mechanisms of biotransformation, toxicodynamics, toxicokinetics and metabolic processes that underlie the formation of structural and metabolic disorders when exposed to surfactants, taking into account possible long-term effects [6, 8].

**Objective:** to investigate the effect of nitrogen-containing surfactants on redox processes in the body of experimental animals.

## MATERIALS AND METHODS

Four ionic nitrogen-containing surfactants with specified technical and physicochemical characteristics were used as research objects: FOM 9, FOM 9-4, FOM 9-12 and FOM 9-20 (FOM is the Mannich phenolic base).

In the experimental part of the work to obtain the required actual material, 620 white rats were used. 128 acute rats (weight 180-220 g) were used in acute experiments.

Experiments on white rats were performed by the method of Behrens-Schlosser [2]. Doses were chosen so as to determine the lethal effect in the range of LD0-LD100. LD50 calculations were performed according to Kerber, Behrens-Schlosser.

Substances were injected into the stomach in pure form using a metal probe. The animals were observed for up to 15 days. The time of death of animals and the total amount of the injected substance was registered. The results were evaluated on the basis of the average effective time of death of the animals [4]. Dead animals and survivors were subjected to pathological autopsy during these observation periods.

Qualitative evaluation of redox processes was studied by the activity of enzymes: ceruloplasmin, lactate dehydrogenase (LDH), malate dehydrogenase (MDG), succinate dehydrogenase (SDG), peroxidase, catalase, cytochrome oxidase and others [5]. To determine the activity of serum oxidase (ceruloplasmin), which directly fixes oxygen, used the method of H.A. Ravin in modification G.A. Babenka (1968) [4]. Cytochrome oxidase activity was determined by G.A. Gudilova and N.I. Sorokina (1968) by oxidation by cytochrome oxidase of reducing cytochrome C [24]. The activity of serum LDH was judged by the amount of pyruvic acid formed, which was determined colorimetrically using 2,4-dinitrophenylhydrazine [3]. The MDG of malic acid was determined by the Warburg test [7]. Determination of blood catalase was performed by Bach and Zubkova [7]. The content of SH-groups in the blood was detected by the method of ampermetric titration with silver nitrate, proposed by Kolthof and Harris, in the modification of V.V. Sokolovsky [9]. The concentration of biogenic monoamines was determined by the method of Y. Endo and Y. Ogura, for their binding was used carboxymethyl cellulose company «Reanal».

## RESULTS AND DISCUSSION

All test substances after the end of the subacute experiment statistically significantly in 1/10 and 1/1000 LD50 reduced serum creatine phosphokinase activity, increased the activity of lactate dehydrogenase, asparagine and alanine aminotransferases, γ-glutamate transferase and Neonol FOM 9-20, neonol FOM 9-4 and FOM 9-12 reduced the activity of α-hydroxybutyrate dehydrogenase. In other cases, there was both an increase and decrease.

In groups of animals under the influence of nitrogen-containing surfactants in 1/10 and 1/100 LD50 there was an increase in the activity of cholinesterase (HE) in serum and acetylcholinesterase (AHE) – in the brain (Table 1). 1/1000 LD50 was inactive according to this indicator.

Cholinesterase is known to be found in the liver, blood plasma and other tissues. In many ways, it is an indicator of the functional activity of the liver and CNS. Therefore, the observed increase in the activity of this enzyme can be interpreted as the primary response of the liver to the action of nitrogen-containing surfactants and its participation in the formation of protective and adaptive mechanisms and the action of xenobiotics.

An important place in the anti-radical protection of the body belongs to peroxidase, which plays a leading role in the decomposition of peroxides and free radicals. Nitrogen-containing surfactants in the dynamics of observation caused a change in the activity of this enzyme both upwards and downwards. In all cases, 1/1000 LD50 was inactive (Table 2).

Thus, on the 15th day of the experiment, neonol FOM 9-12 reduced the activity of the enzyme, and the other substances did not affect it. By the end of the subacute experiment, neonol FOM 9-4 and neonol FOM 9-12 were

Table 1

**Dynamics of XE and ACE activity in white rats in a subacute experiment (M±m), Δ pH/1 year**

| Substance | Dose, LD50 | Observation period, days | | |
|---|---|---|---|---|
| | | HE (blood serum), pH/1 year | | AHE (brain) |
| | | 15 days | 30 days | 30 days |
| Control | | 0,375±0,03 | 0,490±0,037 | 0,065±0,010 ↑ |
| FOM-9 | 1/10 | 0,466±0,02 ↑ | 0,860±0,04 ↑ | 0,129±0,012 ↑ |
| | 1/100 | 0,443±0,03 ↑ | 0,754±0,03 ↑ | 0,140±0,014 ↑ |
| Neonol FOM 9-4 | 1/10 | 0,526±0,03 ↑ | 0,931±0,14 ↑ | 0,960±0,009 ↑ |
| | 1/100 | 0,429±0,01 ↑ | 0,820±0,07 ↑ | 0,156±0,023 ↑ |
| Neonol FOM 9-12 | 1/10 | 0,536±0,03 ↑ | 0,794±0,06 ↑ | 0,112±0,005 ↑ |
| | 1/100 | 0,487±0,02 ↑ | 0,916±0,08 | 0,136±0,090 ↑ |
| Neonol FOM 9-20 | 1/10 | 0,475±0,02 ↑ | 1,183±0,05 ↑ | 0,113±0,005 ↑ |
| | 1/100 | 0,520±0,03 ↑ | 0,679±0,031 ↑ | 0,140±0,008 ↑ |

Note: ↑ - increase activity, P<0,05

Table 2

**Dynamics of blood peroxidase activity (c) in a subacute experiment**

| Substance | Dose, LD50 | Observation period, days | | | |
|---|---|---|---|---|---|
| | | 15 days | | 30 days | |
| | | M±m | P | M±m | P |
| Control | | 80,83±5,83 | | 52,50±2,14 | |
| FOM-9 | 1/10 | 98,32±4,72 | >0,05 | 44,73±3,28 | >0,05 |
| | 1/100 | 96,15±6,13 | >0,05 | 45,81±2,17 | >0,05 |
| Neonol FOM 9-4 | 1/10 | 67,40±3,15 | >0,05 | 36,45±4,63 ↓ | <0,05 |
| | 1/100 | 65,12±4,18 | >0,05 | 37,29±2,85 ↓ | <0,05 |
| Neonol FOM 9-12 | 1/10 | 57,83±5,19 ↓ | <0,05 | 40,26±3,17 ↓ | <0,05 |
| | 1/100 | 68,74±4,60 | >0,05 | 41,38±4,29 ↓ | <0,05 |
| Neonol FOM 9-20 | 1/10 | 80,55±2,46 | >0,05 | 93,34±9,62 ↑ | <0,05 |
| | 1/100 | 84,27±3,85 | >0,05 | 95,82±8,30 ↑ | <0,05 |

Note: ↑ – increase activity; ↓ – decrease activity

Table 3

**Dynamics of blood catalase (C) activity in a subacute experiment**

| Substance | Dose, LD50 | Observation period, days | | | |
|---|---|---|---|---|---|
| | | 15 days | | 30 days | |
| | | M±m | P | M±m | P |
| Control | | 80,83±5,83 | | 52,50±2,14 | |
| FOM-9 | 1/10 | 98,32±4,72 | >0,05 | 44,73±3,28 | >0,05 |
| | 1/100 | 96,15±6,13 | >0,05 | 45,81±2,17 | >0,05 |
| Neonol FOM 9-4 | 1/10 | 67,40±3,15 | >0,05 | 36,45±4,63 ↓ | <0,05 |
| | 1/100 | 65,12±4,18 | >0,05 | 37,29±2,85 ↓ | <0,05 |
| Neonol FOM 9-12 | 1/10 | 57,83±5,19 ↓ | <0,05 | 40,26±3,17 ↓ | <0,05 |
| | 1/100 | 68,74±4,60 | >0,05 | 41,38±4,29 ↓ | <0,05 |
| Neonol FOM 9-20 | 1/10 | 80,55±2,46 | >0,05 | 93,34±9,62 ↑ | <0,05 |
| | 1/100 | 84,27±3,85 | >0,05 | 95,82±8,30 ↑ | <0,05 |

Note: ↑ – increase activity; ↓ – decrease activity

Table 4

**The content of the SH group (mg%) in the blood of white rats**

| Substance | Dose, LD50 | Observation period, days | | | |
|---|---|---|---|---|---|
| | | 15 days | | 30 days | |
| | | M±m | P | M±m | P |
| Control | | 82,57±2,84 | | 84,71±3,50 | |
| FOM-9 | 1/10 | 69,20±1,35 | <0,05 | 62,17±2,11 | <0,05 |
| | 1/100 | 76,35±4,26 | >0,05 | 79,15±3,86 | >0,05 |
| Neonol FOM 9-4 | 1/10 | 78,52±3,64 | >0,05 | 66,32±2,94 | <0,05 |
| | 1/100 | 80,38±5,16 | >0,05 | 88,57±3,25 | >0,05 |
| Neonol FOM 9-12 | 1/10 | 86,22±4,13 | >0,05 | 64,25±3,17 | <0,05 |
| | 1/100 | 80,35±2,97 | >0,05 | 87,19±4,61 | >0,05 |
| Neonol FOM 9-20 | 1/10 | 85,43±2,15 | >0,05 | 70,38±2,26 | <0,05 |
| | 1/100 | 81,92±6,24 | >0,05 | 89,63±4,35 | >0,05 |

Table 5

**The content of glutathione (mg%) in the blood of white rats**

| Substance | Dose, LD50 | Observation period, days | | | |
|---|---|---|---|---|---|
| | | 15 days | | 30 days | |
| | | M±m | P | M±m | P |
| Control | | 13,70±2,24 | | 12,68±1,93 | |
| FOM-9 | 1/10 | 12,10±3,26 | <0,05 | 8,74±1,66 | <0,05 |
| | 1/100 | 14,29±1,83 | >0,05 | 14,72±2,25 | >0,05 |
| Neonol FOM 9-4 | 1/10 | 11,74±3,46 | >0,05 | 7,96±2,16 | <0,05 |
| | 1/100 | 12,15±1,92 | >0,05 | 15,96±2,37 | >0,05 |
| Neonol FOM 9-12 | 1/10 | 11,79±2,78 | >0,05 | 10,42±3,58 | <0,05 |
| | 1/100 | 14,16±3,56 | >0,05 | 14,13±2,74 | >0,05 |
| Neonol FOM 9-20 | 1/10 | 10,23±3,74 | >0,05 | 112,82±3,19 | <0,05 |
| | 1/100 | 15,48±1,87 | >0,05 | 13,66±2,78 | >0,05 |

reduced, and neonol FOM 9-20 increased peroxidase activity.

The studied nitrogen-containing surfactants had a similar effect on catalase activity (Table 3). In all groups of animals, except 1/1000 LD50, for 30 days there was a decrease in its activity. The detected changes in enzymatic activity may be associated with depletion of function as a result of the accumulation in the body of peroxides, hydroperoxides, free radicals.

It is known that surfactants, acting on the cell membrane, disrupt the structure of unsaturated fatty acids, which are sources of free radicals, and surfactants themselves, metabolized in the body, form peroxides, hydroperoxides, aldehydes, ketones. These are the sources to quench the consumption of this enzyme. It can be assumed that nitrogen-containing surfactants in 1/10 and 1/100 LD50 lead to the accumulation in the body of underoxidized products in the form of peroxides, hydroperoxides, aldehydes, free radicals, ketones and others. FOM-9 and neonol FOM 9-4 had a stronger effect on the state of the antioxidant system. Studies have shown that surfactants to some extent in the tested doses affect the content of SH-groups in the blood of white rats (Table 4).

As can be seen from the table above, on the 15th day of the experiment there was a tendency to decrease, which turns into significant differences on the 30th day of the experiment in 1/10 LD50. The effect of 1/100 and 1/1000 LD50 did not disrupt the dynamics of the content of SH-blood groups. Redox processes in tissues and organs are known to be maintained at a certain level by the ratio of sulfhydryl SH groups and disulfide SS groups in proteins and especially in enzyme proteins. The catalytic properties of many enzymes, such as β-amylase, carboxylase, cholinesterase, and others, as well as the processes of tissue respiration and detoxification of poisons, are associated with free SH groups. Sulfhydryl groups are the active principle of coenzyme A, which is involved in many processes of intermediate metabolism. Sulfur-containing enzymes lose catalytic activity when blocking SH groups of proteins.

Thus, the reduction of sulfhydryl groups under the influence of 1/10 LD50 nitrogen-containing surfactants may indicate a violation of redox processes in animals that have been seeded with this dose. Insignificant increase of SH-groups under the influence of 1/100 LD50 can be considered as a compensatory-adaptive reaction. The threshold, therefore, is 1/100 LD50.

Nitrogen-containing surfactants have a similar effect on the dynamics of the blood content of the tripeptide – glutathione and sulfhydryl groups (Table 5).

However, it should be noted that the severity of the shifts is somewhat weaker in relation to the effect of substances on blood glutathione. As can be seen from the table, on the 15th day there was a tendency to reduce it to 1/10 LD50 in all groups of animals. By the end of the subacute experiment, the test compounds FOM-9 and neonol FOM 9-4 reduced this value in the blood, 1/100 LD50 led to its increase, although it is not statistically significant that it should be considered as a protective and adaptive response of the body to toxic surfactants. threshold, and 1/10 LD50 – the current value.

In a subacute experiment in groups of animals exposed to nitrogen-containing surfactants 1/10 and 1/100 LD50, a change in the dynamics of biogenic monoamines and their precursors in the brain and liver was detected. Thus, in the liver there was an increase in noradrenaline, tryptophan, serotonin and a decrease in DOPA and dopamine. The dynamics of adrenaline did not change. In the brain, the changes were less pronounced and were characterized by an increase in dopamine and norepinephrine. Other indicators (DOPA, adrenaline) did not differ from the control. Tryptophan increased only under the influence of FOM-9. 1/1000 LD50 did not affect the dynamics of the content of biogenic monoamines and their precursors in the liver and brain of experimental animals.

The results of the studies confirm that the tested drugs have a similar effect on the body.

## CONCLUSIONS

1 1. A more toxic substance in a subacute experiment is FOM-9.

2. The severity of violations in the dynamics of observation of enzyme activity has a close dose dependence. The effective dose is set at 1/10, the threshold - 1/100 and the inactive - 1/1000 LD50.

3. Common features of the biological action of nitrogen-containing surfactants are violations of redox processes, bioenergy, oxidative phosphorylation, which under appropriate conditions lead to pathology of vital organs, functions and systems of the body.

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## ЗМІНИ ОКИСЛЮВАЛЬНО-ВІДНОВНИХ ПРОЦЕСІВ В ОРГАНІЗМІ БІЛИХ ЩУРІВ ПІД ВПЛИВОМ АЗОТВМІСНИХ ПОВЕРХНЕВО-АКТИВНИХ РЕЧОВИН

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**Актуальність.** Повсякденний контакт населення з поверхнево-активними речовинами (ПАР) у питній воді ставить задачу своєчасного і оперативного обґрунтування донозологічних високочутливих показників ранніх проявів біологічної активності детергентів і оперативного контролю за станом здоров'я населення і навколишнього середовища. Але сьогодні ще не до кінця з'ясовані механізми біотрансформації, токсикодинаміки, токсикокинетики і метаболічних процесів, що лежать в основі формування структурно-метаболічних порушень при дії на організм ПАР з урахуванням можливих віддалених ефектів.

**Мета:** дослідити вплив азотовмісних поверхнево-активних речовин на окислювально-відновні процеси в організмі експериментальних тварин.

**Матеріали та методи.** Досліди проведено на 620, а гострі досліди – на 128 білих щурах (маса 180-220 г). Використовували чотири іоногенних азотовмісних ПАР с заданими технічними та фізико-хімічними характеристиками: ФОМ 9, ФОМ 9-4, ФОМ 9-12 та ФОМ 9-20. Дози обирали так, щоб визначити летальний ефект в інтервалі ЛД0-ЛД100. Розраховували ЛД50. Речовини вводили в шлунок у чистому виді за допомогою металевого зонду. Спостерігали за тваринами до 15 днів. Реєстрували час загибелі тварин і сумарну кількість введеної речовини. Тварини підлягали патологоанатомічному розтину. Якісно оцінювали окислювально-відновлювані процеси за активністю ферментів: холінестерази, церулозплазміну, лактатдегідрогенази, малатдегідрогенази, сукцинатдегідрогенази, пероксидази, каталази, цитохромоксидази, за вмістом SH-груп у крові, за концентрацію біогенних моноамінів (адреналіну, норадреналіну, триптофану, серотоніну, ДОФА і дофаміну).

**Результати.** Азотовмісні ПАР викликали зміну активності пероксидази як у бік підвищення, так і зниження. У всіх випадках 1/1000 ЛД50 була недіючою. На 15 добу досліду неонол ФОМ 9-12 знижував активність ферменту, а решта речовин не чинили на нього впливу. До закінчення підгострого експерименту неонол ФОМ 9-4 і неонол ФОМ 9-12 знижували, а неонол ФОМ 9-20 підвищував активність пероксидази. Подібний вплив був і на активність каталази: у всіх групах, крім 1/1000 ЛД50, на 30 добу спостерігалося зниження її активності. Активність холінестерази підвищувалася. Для вмісту SH-груп в крові на 15 добу відзначалася тенденція до їх зниження, що переходила в достовірні відмінності на 30 добу в 1/10 ЛД50. Вплив 1/100 і 1/1000 ЛД50 не порушував вміст SH-груп крові. Подібний вплив був і на вміст у крові глутатіону. У підгострому досліді, у групах 1/10 і 1/100 ЛД50, в печінці збільшувався вміст норадреналіну, триптофану, серотоніну і знижувався ДОФА і дофаміну. Динаміка адреналіну не змінювалася. В головному мозку в меншій мірі збільшувався вміст дофаміну та норадреналіну; ДОФА і адреналін не відрізнялися від контролю; триптофан же підвищувався тільки під впливом ФОМ-9. 1/1000 ЛД50 не чинила впливу на динаміку вмісту біогенних моноамінів. Випробовувані препарати мають схожу дію на організм.

**Висновки.** Більш токсичною речовиною в підгострому досліді є ФОМ-9. Виразність порушень в динаміці спостереження активності ферментів має тісну дозову залежність. Діюча доза визначена на рівні 1/10, порогова – 1/100 і недіюча – 1/1000 ЛД50. Спільними особливостями біологічної дії азотовмісних поверхнево-активних речовин є порушення окислювально-відновних процесів, біоенергетики, окислювального фосфорилювання, які за відповідних умов призводять до патології життєво важливих органів, функцій і систем організму.

**Ключові слова:** азотовмісні поверхнево-активні речовини, окислювально-відновні процеси, біологічна дія, дозова залежність.

# ИЗМЕНЕНИЕ ОКИСЛИТЕЛЬНО-ВОССТАНОВИТЕЛЬНЫХ ПРОЦЕССОВ В ОРГАНИЗМЕ БЕЛЫХ КРЫС ПОД ВЛИЯНИЕМ АЗОТСОДЕРЖАЩИХ ПОВЕРХНОСТНО-АКТИВНЫХ ВЕЩЕСТВ

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**Актуальность.** Повседневный контакт населения с поверхностно-активными веществами (ПАВ) в воде ставит задачу своевременного и оперативного обоснования донозологичних высокочувствительных показателей ранних проявлений биологической активности моющих средств и оперативного контроля за состоянием здоровья населения и окружающей среды. Но сегодня еще не до конца выяснены механизмы биотрансформации, токсикодинамики, токсикокинетики и метаболических процессов, лежащих в основе формирования структурно-метаболических нарушений при воздействии на организм ПАВ с учетом возможных отдаленных эффектов.

**Цель:** исследовать влияние азотсодержащих поверхностно-активных веществ на окислительно-восстановительные процессы в организме экспериментальных животных.

**Материалы и методы.** Опыты проведены на 620, а острые опыты – на 128 белых крысах (масса 180-220 г). Использовали четыре ионогенных азотсодержащих ПАВ с заданными техническими и физико-химическими характеристиками: ФОМ 9, ФОМ 9-4, ФОМ 9-12 и ФОМ 9-20. Дозы выбирали так, чтобы определить летальный эффект в интервале ЛД0-ЛД100. Рассчитывали ЛД50. Вещества вводили в желудок в чистом виде с помощью металлического зонда. Наблюдали за животными до 15 дней. Регистрировали время гибели животных и суммарное количество введенного вещества. Животные подлежали патологоанатомическому вскрытию. Качественно оценивали окислительно-восстановительные процессы по активности ферментов: холинэстеразы, церулозплазмину, лактатдегидрогеназы, малатдегидрогеназы, сукцинатдегидрогеназы, пероксидазы, каталазы, цитохромоксидазы, по содержанию SH-групп в крови, по концентрации биогенных моноаминов (адреналина, норадреналина, триптофана, серотонина, ДОФА и дофамина).

**Результаты.** Азотсодержащие ПАВ вызвали изменение активности пероксидазы как в сторону повышения, так и снижения. Во всех случаях 1/1000 ЛД50 была недействующей. На 15 сутки опыта неонол ФОМ 9-12 снижал активность фермента, а остальные вещества не оказывали на него влияния. До окончания подострого эксперимента неонол ФОМ 9-4 и неонол ФОМ 9-12 снижали, а неонол ФОМ 9-20 повышал активность пероксидазы. Подобное влияние было и на активность каталазы: во всех группах, кроме 1/1000 ЛД50, на 30 сутки наблюдалось снижение ее активности. Активность холинэстеразы повышалась. Для содержания SH-групп в крови на 15 сутки отмечалась тенденция к снижению, переходящая в достоверные различия на 30 сутки в 1/10 ЛД50. Влияние 1/100 и 1/1000 ЛД50 не нарушало содержание SH-групп крови. Подобное влияние было и на содержание в крови глутатиона. В подостром опыте, в группах 1/10 и 1/100 ЛД50, в печени увеличивалось содержание норадреналина, триптофана, серотонина и снижалось – ДОФА и дофамина. Динамика адреналина не менялась. В головном мозге в меньшей степени увеличивалось содержание дофамина и норадреналина; ДОФА и адреналин не отличались от контроля; триптофан же повышался только под влиянием ФОМ 9. 1/1000 ЛД50 не оказывала влияния на динамику содержания биогенных моноаминов. Испытуемые препараты обладают схожим действием на организм.

**Выводы.** Более токсичным веществом в подостром опыте есть ФОМ 9. Выраженность нарушений в динамике наблюдения активности ферментов имеет тесную дозовую зависимость. Действующая доза определена на уровне 1/10, пороговая – 1/100 и недействующая – 1/1000 ЛД50. Общими особенностями биологического действия азотсодержащих поверхностно-активных веществ является нарушение окислительно-восстановительных процессов, биоэнергетики, окислительного фосфорилирования, которые при соответствующих условиях приводят к патологии жизненно важных органов, функций и систем организма.

**Ключевые слова:** азотсодержащие поверхностно-активные вещества, окислительно-восстановительные процессы, биологическое действие, дозовая зависимость.