Effect of pesticides "Butylcaptax (Russia)" and "Droppa (Russia)" on respiration and oxidative phosphorylation of liver mitochondria of pregnant rats and their embryos

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Abstract. The article provides information on the effect of pesticides - butylcaptax and droppa on respiration and oxidative phosphorylation of liver mitochondria in rat rats and their embryos. It has been shown that butylcaptax and droppa reduce the oxidation of succinate and α-ketoglutarate in the V4*, V3 and V_{dnf} states and drug conjugation in the liver mitochondria of pregnant animals and their embryos. The most significant inhibition of ADF formation in the respiratory chain of fatal and maternal liver mitochondria occurs via the NAD-dependent pathway, especially when poisoning with butylcaptax on the 19th day of pregnancy. Apparently, inhibition of ADF-stimulated respiration is associated with inhibition of electron transfer along the respiratory chain or is a consequence of inhibition of the transport of phosphate or ADF into mitochondria, which plays a key role in the mechanism of oxidative phosphorylation. A decrease in the conjugation of oxidation and phosphorylation does not create conditions for the accumulation of energy in an utilizable form - in the form of ADF.

1 Introduction

The accumulation of toxic chemicals in the body of pregnant women is extremely dangerous. It leads not only to chronic intoxication, but also to genetic shifts in the offspring [1].

In recent years, more and more supporters have been winning the hypothesis about the dominant role of energy deficiency in the development of diseases of chemical ethology [1, 2]. Regardless of whether the damaging agents act directly on the mitochondrial membranes or this effect is mediated by intermediate factors, membranes react subtly to the action of chemical agents by changing the structural characteristics and activity of membrane-bound enzymes. In other words, the reaction and state of these organelles reflect the state of the entire cell.

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The most important component of the differentiation of the structure and functions of the liver is the formation of physiological, biochemical functions and mechanisms of their regulation. The study of these processes is necessary to understand the causes of deviations during the period of individual development of the organism and to develop methods for treating pathologies.

The role of cell organelles in the overall metabolism of cells, including hepatocytes, changes significantly during embryonic development. During the prenatal period in mammals and birds, both the morphology and metabolism of liver mitochondria change significantly [3, 4].

Mitochondria are special organelles of the cell, the intracellular center of aerobic respiration. In a cell, depending on its type and function, there are from several tens to several thousand mitochondria.

The structure of mitochondria was studied by electron microscopy. Their size and shape are tissue-specific and change during development [5].

Such results indicate that the inner mitochondrial membrane undergoes maturation processes during the prenatal period. As a result, the content of adenine nucleotides increases, and, consequently, respiratory control (DK) of mitochondria [6].

In mammals, the supply of oxygen to embryonic tissues increases after the formation of the placenta. The enzymes included in the respiratory chain and involved in respiration and oxidative phosphorylation are functionally active. This is consistent with the fact that on the 11-12th day, oxygen uptake in the embryonic tissue increases, mitochondrial functions increase, and glycolysis decreases [7].

Changes in the fine structure of mitochondria coincide with biochemical changes in their metabolism. The low rate of oxygen uptake in 1-4 - cell mouse embryos begins to increase at the 8 cell stage and grows 3.5 times at the blastocyst stage. An increase in the utilization of substrates of the tricarboxylic acid cycle at the stage of 4-8 cells indicates an increase in the permeability and transport of substrates into mitochondria [8].

At the early stages of embryogenesis, there is a high conjugation of respiration and phosphorylation, and at the later stages, these processes are disconnected [8]. In the mitochondria of the liver of embryos, the respiratory control index is low; therefore, they are not efficient producers of ADF [9]. This is due to the low rate of ADF-stimulated respiration. The respiration rate in the V4 state is also low, which indicates the lack of communication between the mitochondria of the liver of embryos; from the 7th to the 21st day of incubation, the level of succinate dehydrogenase and cytochrome oxidase increases [10].

Enzymatic systems are localized in mitochondria, which carry out transformations of Krebs cycle intermediates, substrate phosphorylation, terminal oxidation and associated oxidative phosphorylation, fatty acid oxidation and complex lipid transformations [11].

It was showed differences between the structures of the outer and inner mitochondrial membranes, as well as between the enzymatic activity and the activity of electron transport in mitochondrial membranes. The main function of the mitochondrial respiratory chain is the oxidation of substrates by the system of electron-carrying molecules, accompanied by the accumulation of oxidation energy and the synthesis of ADF [12].

NAD.H-oxidase system, catalyzing the oxidation of NAD-H with oxygen and reducing coenzyme Q, is the main mechanism of the conjugated respiratory chain. It is divided into flavoprotein and non-heme iron protein [13].

The succinate oxidase system occupies a special position among the energy-generating systems of the cell. The initial link of this system is the reaction of oxidation of succinic acid to fumaric acid, which is catalyzed by succinate dehydrogenase - succinate dehydrogenase, being part of the polyenzyme complex of succinate oxidase, structurally

and functionally linked to the inner mitochondrial membrane and localized on its inner side [14].

Cytochrome with oxidase is a terminal enzyme of the respiratory chain. The reducing agent of cytochrome oxidase is cytochrome, located in the intermembrane space. This enzyme combines with oxygen and rapidly reduces oxygen to 2 water molecules [15]. The cytochrome oxidase subunit also interacts with phospholipids of mitochondrial membranes [16].

The vital activity of the cell supports the functioning of complex enzymatic assemblies associated with biomembranes. The state of membranes largely determines the biosynthesis of protein, nucleic acids, and lipids, the synthesis and degradation of high-energy substrates, the transport of substances and the utilization of intermediate metabolic products [17].

The effect of pesticides on the structural and functional state of mitochondria is one of the important areas of toxicology, which is due to the large role of these organelles in the energy supply of cell functioning. The inner membranes of mitochondria are called "conjugate" membranes, since they include enzymes for electron transfer and associated phosphorylation. “Conjugating” membranes are characterized by another feature - a strong dependence of the functioning of enzymes on the integrity of the membrane structure [15].

The high sensitivity of biomembranes to the action of external factors is primarily due to their complex structural organization, which ensures the direction and speed of a particular cellular function.

Fazalone has a pronounced membrane toxic effect. It causes swelling and destruction of mitochondrial membranes, reduction of cristae, which is a sign of the effect of this toxic chemical on the bioenergetic potential of the cell [11, 17].

Some groups of pesticides are capable of inhibiting the mitochondrial respiratory chain, uncoupling the processes of oxidative phosphorylation and thereby disrupting the energy supply of the liver tissue [17]. DDT and sevine reduce the intensity of oxidative phosphorylation, not only reducing oxygen uptake, but also uncoupling it. At the same time, sevine has a greater inhibitory effect when used as a substrate of succinic acid (phosphorylation decreases by 42%, respiration - by 20%), and DDT-ketoglutaric acid (phosphorylation decreases by 70%, respiration - by 38%). The authors suggest that the common in the mechanism of action of both pesticides is determined by their ability to dissolve in lipids.

Lipid-soluble substances of the aromatic structure increase the membrane permeability for protons and thus reduce the membrane potential, inhibit oxidative phosphorylation [6, 10].

In connection with the above, we studied the effect of butylcaptax and droppa on the oxidative phosphorylation systems in the liver mitochondria of pregnant rats and their embryos.

2 Materials and methods

The objects of research were white Wistar female rats weighing 180-180 g. The inoculation of animals with butylcaptax and droppa at a dose of 1/10 LD50 was performed on the 3rd, 13th and 19th days of pregnancy intragastrically per os using a special probe for 5 days. To fertilize rats in the proestrus-estrus stage, they were placed overnight with males in a ratio of 3:1. The first day of pregnancy was considered the day of detection of sperm in vaginal smears. The animals were slaughtered on the 20th day of pregnancy, when the embryo reached a significant size, at the end of organogenesis. In the experiments, we used the mitochondria of the liver of embryos and the maternal organism.

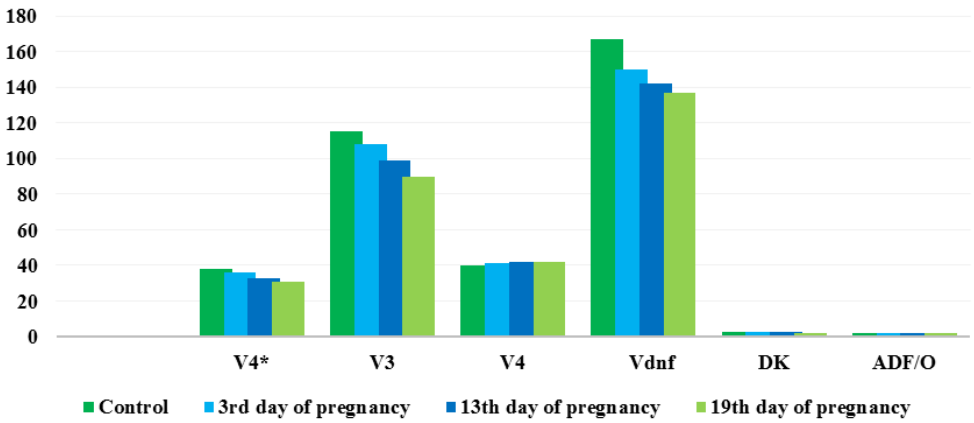
Mitochondria were isolated by the method of differential centrifugation [16]. The rat was decapitated; the removed liver was placed in a beaker with a cooled isolation medium.

The rate of oxygen consumption by mitochondria was measured by the polarographic method on an LP-7 polarograph using a rotating electrode under standard conditions at 25°C. The ADF/0 and DK ratios were expressed according to Chance-Williams [10-15]. Succinate and α-ketoglutarate served as oxidation substrates.

3 Results and discussion

The experiment used mitochondria subjected to a single freeze-thaw. Enzymatic activities were expressed in μ moles of oxygen consumed in 1 min, calculated per 1 mg of mitochondrial protein.

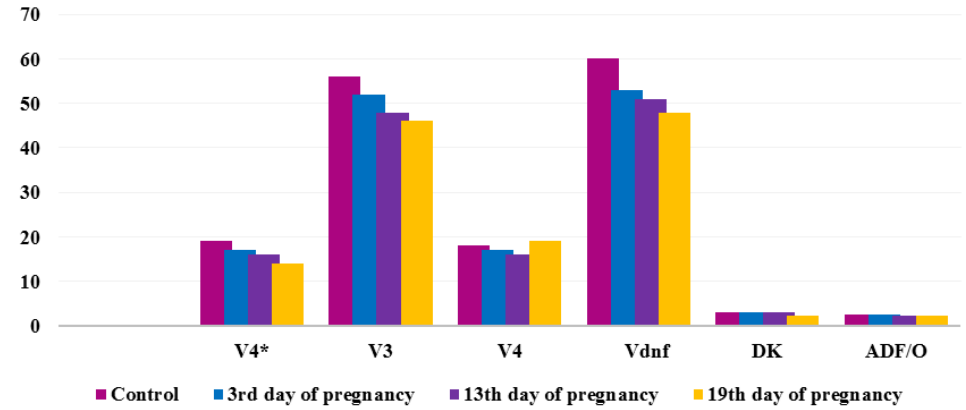
Data on the effect of butylcaptax and droppa on respiration and oxidative phosphorylation in the mitochondria of the liver of embryos and the maternal organism on the 3rd, 13th and 19th days of pregnancy are presented in Figures 1 and 2.



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

Fig. 1. Effect of butylcaptax on respiration and oxidative phosphorylation of liver mitochondria in pregnant rats (succinate), M ± m (n = 8)

Administration of butylcaptax to pregnant rats induces unidirectional changes in the functional parameters of liver mitochondria. In particular, in case of poisoning with this pesticide at a dose of 1/10 LD50 on the 3rd day of pregnancy, the respiration rate of the liver mitochondria of the maternal organism (in samples with succinate) in metabolic states V4*, V3 and V_{dnf} decreased by 5, 7, and 11%, respectively. In the V4 state, it practically did not change. As a result, the DK value, which was defined as the ratio of the respiration rates of mitochondria in metabolic states and V3, decreased by 10%. An insignificant decrease in the ADF/0 coefficient was also observed.

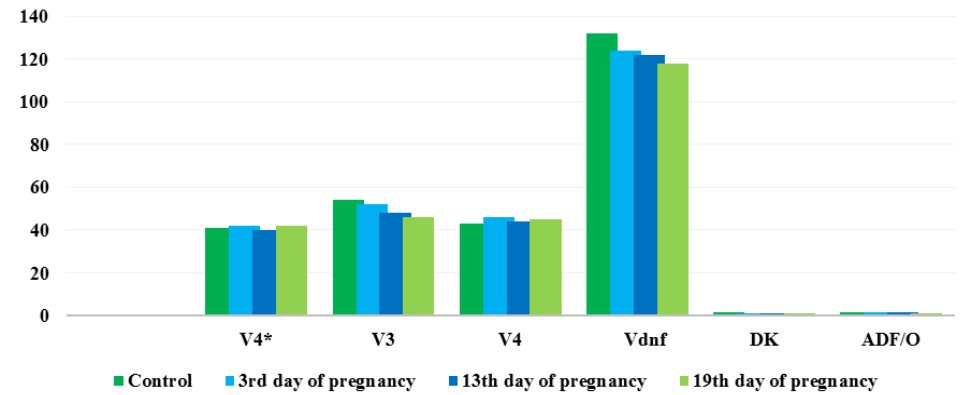


Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

Fig. 2. Effect of butylcaptax on respiration and oxidative phosphorylation of liver mitochondria in pregnant rats (α-ketoglutarate), M ± m (n = 8)

In experiments with α-ketoglutarate under the same conditions, changes in respiration and oxidative phosphorylation of liver mitochondria were unidirectional. In particular, the respiratory rate decreased insignificantly in the V4* and V3 states, and in the V4 state this indicator practically did not differ from the control. As a result, DK decreased by 5%. In this case, the ADF/0 ratio remained at the control level.

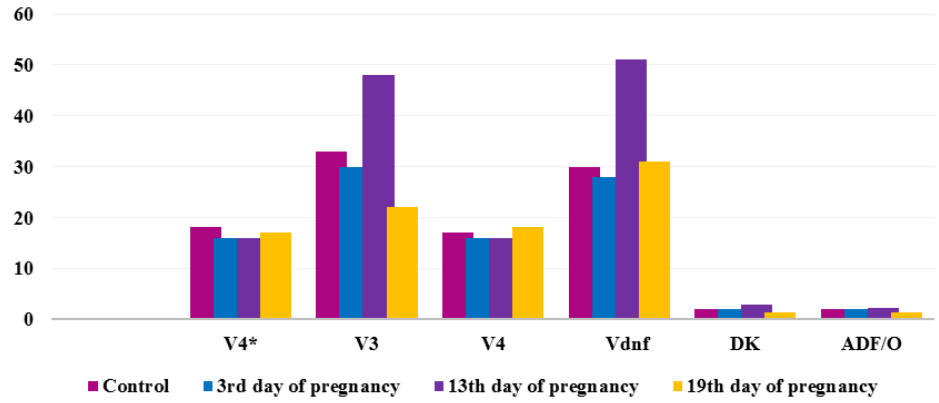
Respiration of mitochondria in a disconnected state (V_{dnf}) decreased by 12%. Similar changes were observed in the respiratory system and oxidative phosphorylation in the mitochondria of the liver of embryos, in case of poisoning with butylcaptax on the 3rd day of development (Figures 3 and 4).



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

Fig. 3. Effect of butylcaptax on respiration and oxidative phosphorylation of liver mitochondria in rat embryos (succinate), M ± m (n = 8)

At the same time, the functional orientation of the metabolism of the respiratory chain of liver mitochondria in 21-day-old embryos of intact rats was characterized by low values of DK and ADF-stimulated respiration. Breathing in the V4* and V4 states in terms of chance did not differ from these parameters of the maternal organism.



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

Fig. 4. Effect of butylcaptax on respiration and oxidative phosphorylation of liver mitochondria in rat embryos (α-ketoglutarate), M ± m (n = 8)

Other authors also reported low DK values during the oxidation of succinate and other substrates in the mitochondria of embryos [16]. In the mitochondria of embryonic tissues, along with the function of energy supply to the cell, the plastic function of redox processes that produce hydrogen and substrates of synthetic reactions is of great importance. Such coordination of the main and alternative functions of biological oxidation is achieved by weakening the functions of free and phosphorylating oxidation, which results in a decrease in DK [17].

In our studies, when rats were poisoned with butylcaptax on the 3rd day of pregnancy in the mitochondria of the liver of embryos, an insignificant decrease in the oxidation of succinate in metabolic states V3 and V_{dnf} (by 4 and 6%), and the respiratory rate in state V4 increased (by 7%). As a result, the indicators of DK and ADF/0 decreased (by 11 and 13%, respectively).

In experiments with α-ketoglutarate, the respiration rate in all metabolic states (V4*, V 3, V4, and V_{dnf}) decreased by 6-12%. At the same time, DK and ADF/0 coefficient remained at the control level.

In case of poisoning with butylcaptax on the 13th day of pregnancy, the rate of succinate oxidation in the liver mitochondria of rats in the V4* state decreased by 14%, in the V3 state - by 14%, and V4 - by 15%. The value did not change significantly, which reduced the DK by 26% and the ADF/0 ratio by 10%.

In experiments with α-ketoglutarate during the same study period, there was a slight decrease in the V3 value (by 18%) compared with the control, as a result of which DK decreased by 25% and the ADF/0 ratio by 12%.

When rats were poisoned on the 13th day of pregnancy in the mitochondria of the embryonic liver, the rate of succinate oxidation in the V3 and V_{dnf} states decreased by 12 and 8%: the respiration rate in the V4* and V4 states did not change, which, in turn, led to a decrease in DK by 16% and ADF/0 ratio by 20%.

However, when an NAD-dependent substrate was used in the same period, a pronounced inhibition of respiration in the metabolic state V3 was noted (by 22%). The rate of α-ketoglutarate oxidation in the V4*, V4, and V_{dnf} states did not differ significantly from the control. Due to these changes, DK decreased by 20%, ADF/0 - by 22%.

The toxic effect of butylcaptax on the bioenergetic potential of the liver mitochondria of the maternal organism and the embryo was manifested in case of poisoning on the 19th day of pregnancy. In particular, in the mitochondria of rat liver, there was a decrease in the

oxidation of succinate and α-ketoglutarate in metabolic states V4*, V3, and V_{dnf}, respectively, by 19, 22, and 18%; by 27, 18 and 20%. The metabolic rate V4 did not practically differ from the control. As a result of such changes, the conjugation of mitochondrial preparations, assessed by DK and ADF/0, decreased with succinate by 26 and 10%, with a-ketoglutarate by 25 and 12%.

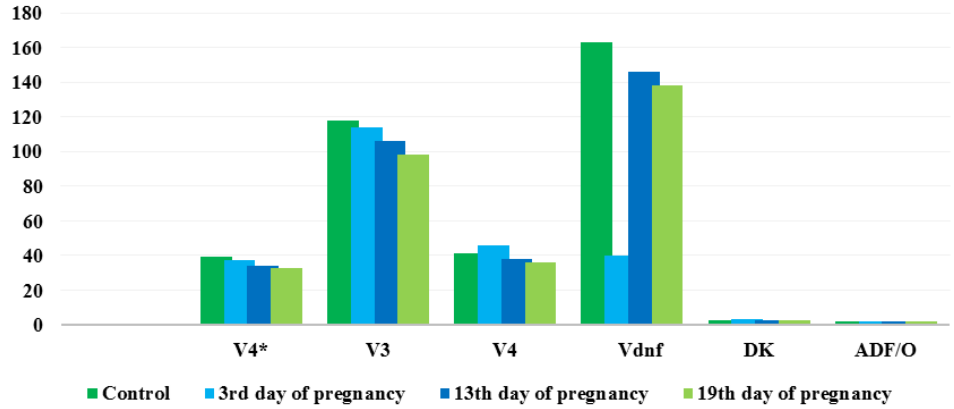
Somewhat different changes were observed in the respiratory system and oxidative phosphorylation in the mitochondria of the liver of embryos during poisoning with butylcaptax on the 19th day of pregnancy. When succinate was used as an oxidation substrate, the rate of phosphorylation oxidation in the V3 state decreased by 15%, V_{dnf} - by 10. At the same time, the DK value decreased by 20% and the ADF/0 ratio by 32%. The level of mitochondrial respiration at rest (V4*) and after depletion of ADF (V4) did not differ from the control.

A similar picture was observed for the NAD-dependent oxidation pathway. In particular, in media with α-ketoglutarate in the metabolic state V3, mitochondrial respiration decreased by 34%. In states V4*, V4, and V_{dnf}, it did not differ significantly from the control. At the same time, the DK indices and the ADF/0 ratio decreased by 37 and 35%, respectively.

Inhibition of ADF-stimulated respiration is apparently associated with inhibition of the respiratory chain and inhibition of the transport of phosphate or ADF, which plays a key role in the mechanism of oxidative phosphorylation, into mitochondria. A decrease in the conjugation of oxidation and phosphorylation, expressed in a decrease in the ADF/0 ratio, does not create conditions for the accumulation of energy in the utilized form - in the form of ADF.

Thus, poisoning with butylcaptax inhibits the transfer of electrons along the respiratory chain and significantly suppresses the associated process of oxidative phosphorylation in the liver mitochondria of the maternal organism and the embryo. The most profound violation was noted in case of poisoning on the 19th day of pregnancy.

In the next series of experiments, we investigated the effect of droppa on the functional parameters of the liver mitochondria of the maternal organism and the embryo, in case of poisoning on the 3rd, 13th and 19th days of pregnancy (Figures 5-8).



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

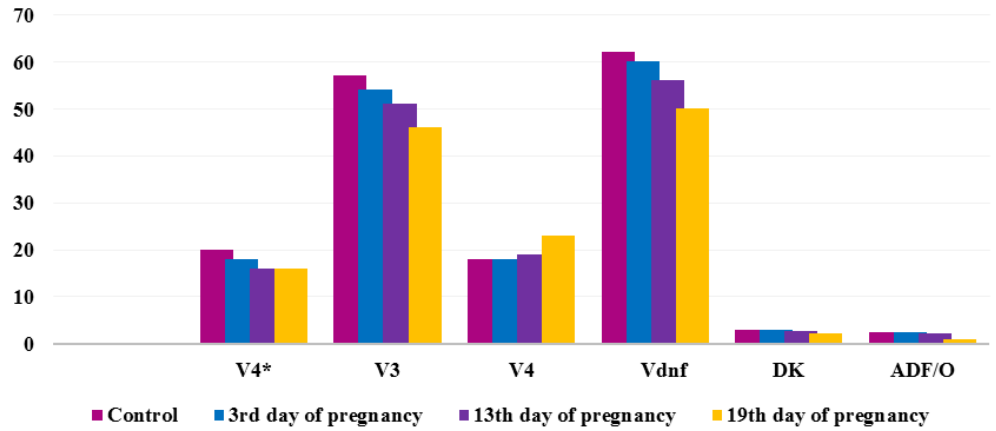
Fig. 5. Effect of droppa on respiration and oxidative phosphorylation of liver mitochondria in pregnant rats (succinate), M ± m (n = 8)

In case of poisoning with this pesticide on the 3rd day of pregnancy, an insignificant decrease in the oxidation of succinate and α-ketoglutarate in the V3 state was observed in

the mitochondria of the liver of the mother and the embryo. The rate of oxidation of substrates in other metabolic states, the DK index and the ADF/0 ratio did not differ from the control. In general, the state of energy metabolism in the mitochondria of the liver of the mother and the embryo, in such conditions, can be considered satisfactory.

Droppa showed the toxic effect on the 13th day of pregnancy. In the mitochondria of the rat liver, there was a decrease in the oxidation of succinate in the states V4*, V3, and V_{dnf} by 11 - 13%. The DK value and the ADF/0 ratio did not change.

In experiments with α-ketoglutarate in this series of experiments, a decrease in respiration was also observed in metabolic states V4* (by 20%), V3 (by 11%), and V_{dnf} (by 10%). The respiration of rat liver mitochondria in the V4 state did not change, as a result of which DK decreased by 14%.



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

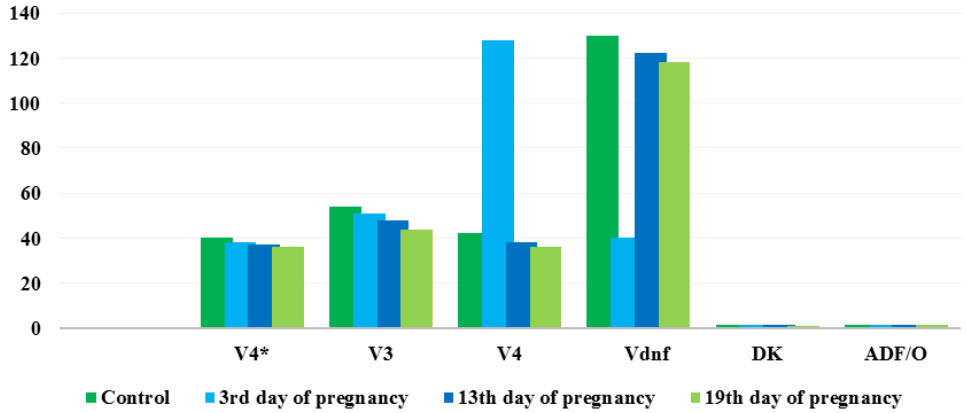
Fig. 6. Effect of droppa on respiration and oxidative phosphorylation of liver mitochondria in pregnant rats (α-ketoglutarate), M ± m (n = 8)

Similar changes were observed in the system of energy metabolism in the mitochondria of the liver of embryos with droppa poisoning on the 13th day of development. The rate of succinate oxidation decreased in all metabolic states (by 7 - 12%). in experiments with α-ketoglutarate, this indicator decreased by 12 - 22%. When succinate was used, DK and ADF/0 did not change, but in experiments with α-ketoglutarate they decreased by 11%.

When poisoned with droppa on the 19th day of pregnancy, its toxic effect increased markedly. Thus, the oxidation of succinate in rat liver mitochondria in metabolic states V4*, V3, V4, and V_{dnf} decreased by 16, 17, 13, and 16%, respectively. DK decreased by 6%, the ADF/0 ratio - by 7%. In experiments with an NAD-dependent substrate, droppa poisoning caused the most pronounced decrease in the V4*, V3 and V_{dnf} values (by 20%). The condition did not change significantly. As a result, the DK decreased by 30%, the ADF/0 coefficient - by 14%.

Unidirectional changes were observed in the respiratory system and oxidative phosphorylation in the liver mitochondria of embryos in case of droppa poisoning on the 19th day of development. At this time, droppa reduced the rate of succinate oxidation in metabolic states V4* (by 10%), V3 (by 19%), V4 (by 15%) and V_{dnf} (by 10%). At the same time, DK and the ADF/0 coefficient decreased by an average of 7%. When α-ketoglutarate was used under the same conditions, a pronounced inhibition of respiration in states V4*, V4, and V_{dnf} was observed by 16, 18, and 25%. The rate of phosphorylating respiration

decreased by 33% compared to the control. As a result, the DK was suppressed by 18%, the ADF/0 coefficient - by 25%.



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

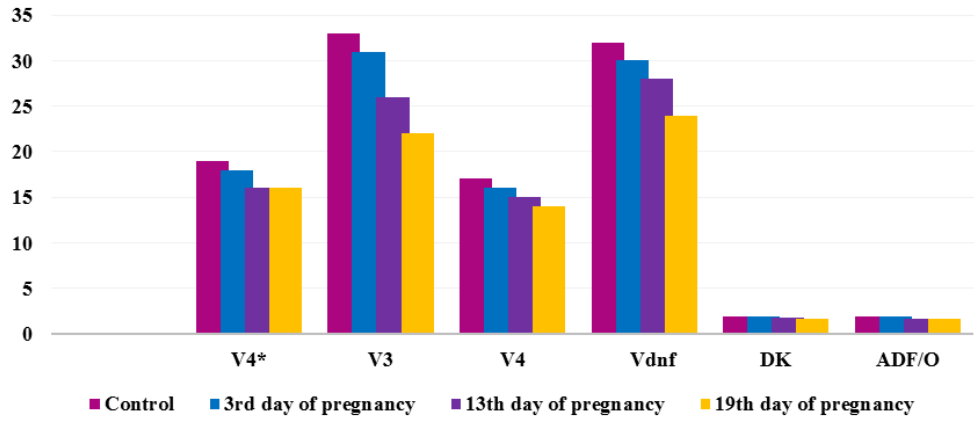
Fig. 7. Effect of droppa on respiration and oxidative phosphorylation of liver mitochondria in rat embryos (succinate), M ± m (n = 8)

As evidenced by the above data, the action of butylcaptax and droppa is characterized by a decrease in the rate of electron transport along the respiratory chain, than with the most profound inhibition falls on the NAD-dependent segment of the respiratory chain of the mitochondria of the liver of the mother and the embryo. Poisoning of the maternal organism with butylcaptax and droppa causes uncoupling of oxidative phosphorylation, which, in turn, leads to disruption of the energy conversion of rat liver mitochondria and their embryos? These changes are most pronounced in case of poisoning on the 13th and 19th days of pregnancy, and they show a higher toxic effect.

Under the action of these pesticides, profound changes occur in the energy supply system of the liver mitochondria of both the mother and the embryo. The results obtained allow us to believe that in the pathogenesis of poisoning with butylcaptax and droppa, a certain role is played by disorders of oxidative-phosphorylating processes in the body.

Thus, butylcaptax and droppa reduce the oxidation of succinate and α-ketoglutarate in V4*, V3 and V_{dnf} states and drug conjugation in liver mitochondria of pregnant animals and their embryos. The most significant inhibition of ADF formation in the respiratory chain of fetal and maternal liver mitochondria occurs via the NAD-dependent pathway, especially when poisoning with butylcaptax on the 19th day of pregnancy. Apparently, inhibition of ADF-stimulated respiration is associated with inhibition of electron transfer along the respiratory chain or is a consequence of inhibition of the transport of phosphate or ADF into mitochondria, which plays a key role in the mechanism of oxidative phosphorylation. A decrease in the conjugation of oxidation and phosphorylation does not create conditions for the accumulation of energy in a utilizable form - in the form of ADF.

Changes in the respiration rate of intact mitochondria can be caused not only by changes in the number of respiratory carriers in the electron transport chain or by selective blocking of it, but also by the microenvironment of the respiratory chain components and the activity of substrate transfer systems across the inner mitochondrial membrane. Butylcaptax and droppa inhibit the rate of electron transfer and oxidative phospholation in the liver mitochondria of the mother and fetus. These disorders are most pronounced in case of poisoning with butylcaptax on the 19th day of pregnancy.



Note: Respiratory rate in oxygen atoms/min x mg protein, P <0.05

Fig. 8. Effect of droppa on respiration and oxidative phosphorylation of liver mitochondria in rat embryos (α-ketoglutarate), M ± m (n = 8)

In the following experiments, we investigated the effect of butylcaptax and droppa on the activity of oxidase systems of the mitochondrial membranes of the liver of pregnant rats and their embryos.

Considerable experimental material has been accumulated on the influence of various environmental factors and chemical preparations on the activity of membrane-bound enzymes and polyenzyme systems of mitochondria. The study of the effect of pesticides on the functioning of the mitochondrial respiratory chain is one of the most important tests used to decipher the primary mechanisms of intoxication.

To fully characterize the toxic effect of butylcaptax and droppa on mitochondrial membranes, in the next series of experiments, we studied the effect of these pesticides on the activity of oxidase systems of rat liver mitochondria and their embryos. In the experiments, we used preparations of mitochondria subjected to a single freezing and thawing.

Poisoning of animals with butylcaptax and droppa differently affects the activity of the oxidase systems of the liver mitochondria of the maternal organism and the embryo. In this case, the toxic effect of butylcaptax is more pronounced.

The activity of the NAD.H-oxidase system of the respiratory chain of rat liver mitochondria and their embryos decreased more significantly during all periods of the study than other enzyme systems. So, if during poisoning with butylcaptax on the 3rd day of pregnancy, the activity of this enzyme in the mitochondria of the mother's liver decreased by 16%, in the mitochondria of embryos - 10%, then the activity of cytochrome-c-oxidase - by 11 and 10%, respectively, the activity of succinate oxidase - by 5 and 8%.

In case of poisoning with butylcaptax on the 13th and 19th days of pregnancy, the changes were more pronounced. In particular, in the mitochondria of the mother's liver, the activity of NAD-H-oxidase decreased by 26 and 40%, respectively, the activity of cytochrome-c-oxidase - by 15 and 20% succinate oxidase - by 11 and 14%. Similar changes were observed in the oxidase system of the embryonic liver mitochondria.

The activity of NAD-H-oxidase decreased by 27 - 32%, following by cytochrome with oxidase by 16 - 22%, succinate oxidase - by 6 - 12%. Similar changes were observed in the polyenzyme system of rat liver mitochondria and their embryos after droppa poisoning, but they were less pronounced.

If the activity of NAD.H-oxidase in the liver mitochondria of the maternal organism under the influence of butylcaptax decreased by an average of 16 - 40%, then under the influence of droppa - by 5 - 25%, the activity of cytochrome with oxidase - by 11 - 25% and 7 - 20%, succinate oxidase - by 5 - 14% and 8 - 11%.

The level of NAD.H-oxidase, cytochrome-c-oxidase and succinate oxidase in the mitochondria of the liver of embryos with droppa poisoning on days 3, 13 and 19 also decreases. The deepest inhibition (by 29%) was observed in NAD.H-oxidase activity (Figures 9 and 10).

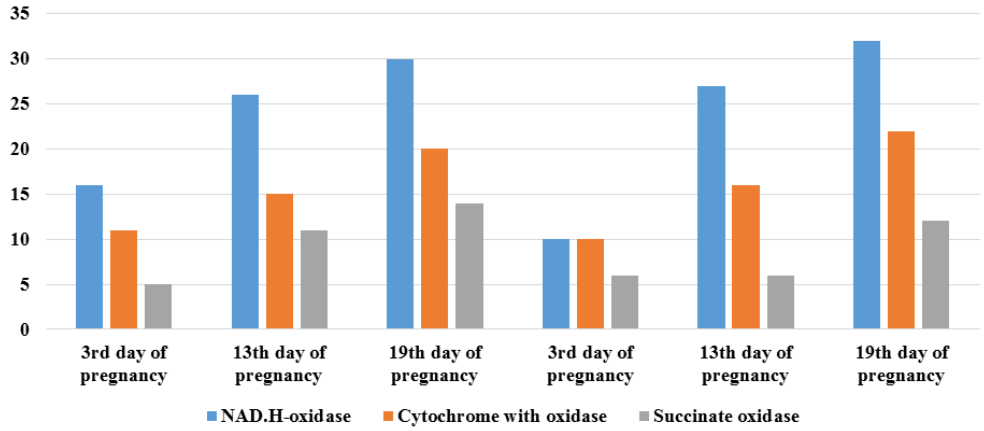


Fig. 9. Effect of butylcaptax on the polyenzyme system of mitochondrial membranes of pregnant rats and their embryos in case of maternal poisoning on the 3rd, 13th and 19th days of pregnancy

Data on the activity of the oxidase systems of the liver mitochondria of embryos indicate a lower toxicity of droppa compared to butylcaptax.

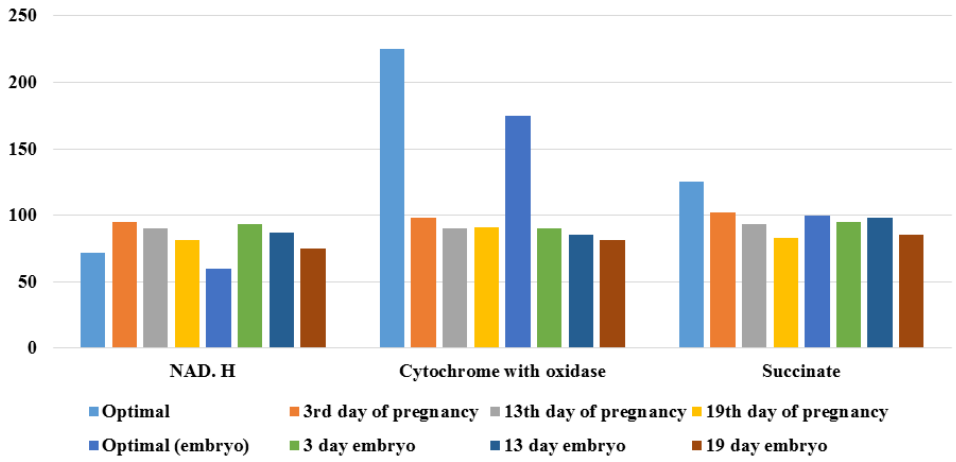


Fig. 10. Influence of droppa on the polyenzyme system of mitochondrial membranes of pregnant rats and their embryos in case of maternal poisoning on the 3rd, 13th and 19th days of pregnancy

Thus, the action of butylcaptax and droppa on the body of pregnant rats decreases the activity of the respiratory chain enzymes of the liver mitochondria of the mother and the embryo. The most significant inhibition occurs in the NAD.H-oxidase branch of the

respiratory chain. Poisoning of rats with these toxic chemicals leads to rather profound disturbances in the oxidative phosphorylation system and in the electron transport chain in the mitochondria of the liver of the mother and embryo. In case of poisoning with butylcaptax, violations are more pronounced.

4 Conclusion

Butylcaptax and droppa inhibit the rate of electron transfer and oxidative phospholation in the liver mitochondria of the mother and fetus. These disorders are most pronounced in case of poisoning with butylcaptax on the 19th day of pregnancy.

The study of the state of the oxidase systems of the mitochondrial membranes of the liver of pregnant rats and embryos shows that butylcaptax and droppa reduce the activities of NAD.H-oxidase, succinate oxidase, and cytochrome with oxidase at all times of inoculation. The most strongly inhibited NAD.H-oxidase activity of mitochondria in pregnant rats and embryos in case of butylcaptax poisoning. Butylcaptax leads to a deeper inhibition of the rate of electron transfer in various fragments of the respiratory chain of liver mitochondria. The most profound inhibition is observed in the NAD.H-oxidase branch during poisoning with butylcaptax on the 19th day of pregnancy.

Thus, the pesticides butylcaptax and droppa cause ultrastructural and, therefore, functional changes in the subcellular components of hepatocytes in pregnant rats and embryos. These changes reduce the protective and adaptive capabilities of the whole organism.

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