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**PEROXIDATION PROCESSES IN THE RABBIT ORGANISM DURING POSTNATAL ONTOGENESIS****Rol N.V.** , **Tsekhmistrenko S.I.** , **Vovkogon A.G.** , **Polishchuk V.M.** , **Polishchuk S.A.** , **Ponomarenko N.V.** , **Fedorchenko M.M.***Bila Tserkva National Agrarian University* E-mail: [natalka290991@gmail.com](mailto:natalka290991@gmail.com)

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One of the pressing problems of modern biochemistry is the problem of adaptation of animal organism to the environment and the formation of an adaptive reaction to the negative impact of production stress factors. Among such adaptive mechanisms for rabbits in the conditions of intensive rabbit meat management is the development of oxidative stress, which causes the accumulation of reactive oxygen species in the body and the development of reactive oxygen pathology.

An important role in the mechanism of adaptation of the body belongs to lipids, because they are a structural component of cell membranes and act as energy and signal systems in cells. Peroxide oxidation of lipids is a compensatory reaction that ensures the functioning of the organism for changes in the environment.

The content of total lipids and peroxide oxidation products of lipids, as well as the activity of enzymes of the antioxidant defense system in rabbits from birth to 90 days of age was investigated. It has been established that the content of total lipids in brain tissues increases throughout the period of postnatal ontogenesis due to the peculiarities of the functional and metabolic activity of brain cells. The content of common lipids is closely related to the processes of lipid peroxide oxidation and the activity of enzymes of antioxidant defense. The growth in concentration of peroxide oxidation products is accompanied by a decrease in the content of total lipids in the rabbit tissues. Reduced content of TBARS-products in rabbit brain tissue from birth to 90-day age was noted. A moderate ( $r = 0.66$ ) correlation between the content of lipid conjugated dienes and lipid hydroperoxides, as well as the strong correlation ( $r = -0.77$ ) between the contents of lipid conjugated dienes and TBARS-products has been established. In the heart of rabbits a reversible moderate ( $r = -0.62$ ) correlation between the content of lipid conjugated dienes and lipid hydroperoxides has been revealed.

**Key words:** rabbits, development, lipid peroxidation, brain, heart, longest muscle of the back.

**Introduction.** The peroxide oxidation processes play an important role in the metabolism of the living organisms. All adaptive and pathological processes occur under conditions of an active form of Oxygen formation and the free radical oxidation intensification of bio substrates. The qualitative and quantitative composition of lipids changes during the period of the body individual development, which largely depends on the free radical oxidation processes.

Modern scientific research results have shown that one of the necessary factors for the

body development is the physiological level of the active form of Oxygen. It's a component of the cellular metabolism that also exerts regulatory function. However, its excessive content in the external and internal environment of the cells can provoke different metabolic disorders [13, 17]. The intensity of the body lipid peroxidation processes is identified due to the control of the reactive oxygen content. The regulation of the active form of Oxygen and the lipid peroxidation intensity in the tissues is conducted by using the components of the antioxidant protection system.

**The aim of the study.** The postnatal ontogeny of New Zealand rabbit breed is worth examining as there is a close connection between the lipid metabolism, the lipid peroxidation products, the total lipid content, the functioning of the antioxidant defense system, the primary and the secondary lipid peroxidation products.

**Materials and methods.** The experimental part of the work has been carried out on New Zealand rabbit breed from birth to the age of 90 days at Gregut company in the Fastivskiy district of the Kyiv region. The brain tissues, heart and the longest back muscle of rabbits have been taken as a study material after slaughter.

The content of the conjugated dienes has been determined by the method of Stalnaya I.D. (1997). As a result of lipid peroxidation, the doubled connections are formed in the oxidized lipid substrate molecules that have a maximum absorption at a wavelength of 233 nm [21].

The content of lipid hydroperoxides has been determined by the method of Romanova L.A., Stalnaya I.D. (1977). The essence of the method lies in the ability of lipid hydroperoxides to oxidize  $Fe^{2+}$  to  $Fe^{3+}$ . It has been determined by using the color reaction with

(Statistica 6.0) (StatSoft, Inc., USA) to determine the statistically significant differences between the mean values.

**Research results.** The lipid peroxidation process is natural for the body tissues. It occurs during the restoration process of the lipid and protein membrane structure and during the large number of the biologically active substance synthesis [7,9,12,19]. Gender is involved in the cell division regulation process and apoptosis modulation. It also provides phagocyte cytotoxicity, prevents malignant cell transformation. Lipid peroxidation products are unstable compounds. They are oxidizable and have cytotoxic, mutagenic effects [8, 15]. These processes lead to impaired cell metabolism, activation of cytosolic and membrane enzymes, cell death [2, 4, 10].

The data presented in Fig. 1 shows that the level of lipid hydroperoxide content in rabbit brain tissues has fluctuated during the study period. Thus, the 30 day-old rabbits have significantly higher indices ( $P \leq 0.05$ ) 22.7 % than the one-day-old. This indicates an increase in lipoperoxidation processes in the postnatal period, as the brain is one of the first organs to undergo free radical oxidation processes.

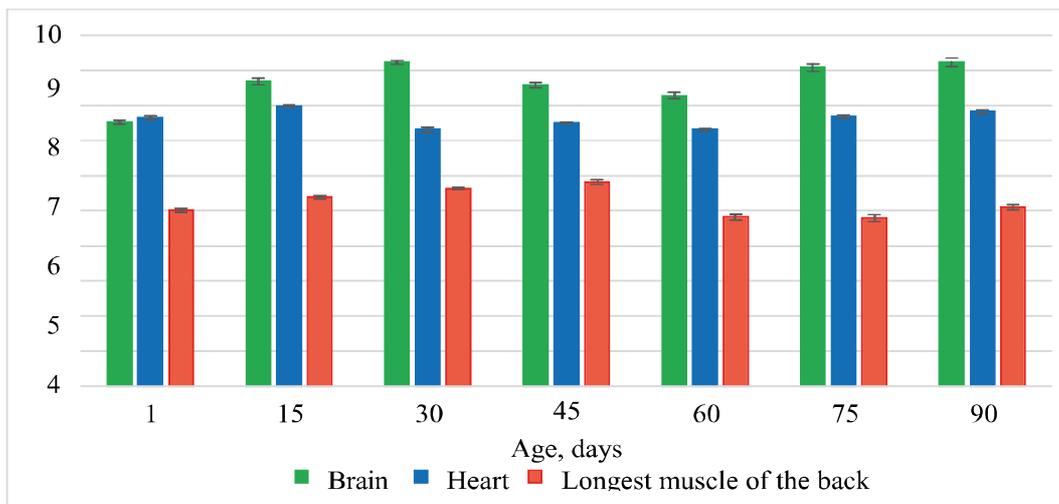


Figure 1. Content of lipid hydroperoxides in organs and tissues of rabbits, UE / g tissue ( $M \pm m$ ,  $n = 5$ ).

ammonium thiocyanate at a wavelength of 480 nm [16].

The content determining method of TBARS-products is the method when the lipid peroxidation products under high temperature and acid environment react with 2-thiobarbituric acid. They create trimethyl complex extracted with trimethyl butane, with a maximum optical absorption at 535 nm [20].

Statistically obtained experimental data has been processed by conventional methods. Student's t-test (t) has been used with a set of software for medical and biological information processing

From the 30th to 90th day the LOOH (LOPs) content in the brain tissues has a significant decreasing tendency. However, the LOOH (LOPs) content reaches 9.23 UE/g in tissues by the 90th day.

During the heart tissue studying the biggest amount of the lipid hydroperoxide content has been observed in 15 day old rabbits. However, during the further rabbit breeding, these indices have decreased. They are lower per (2.4 %) than in one day old rabbits by the 90th day. The LOOH (LOPs). content fluctuates in the longest

back muscle. From birth to the 15th day of the rabbit life, its content increases by 7.4 %. On the 45th day there is a significant increase by 15.9 % in the one day old rabbits. From the 45th to 75th day, there is a decrease of the LOOH. (LOPs) content in the longest back muscle tissues. Thus on the 60th day it decreases by 16.9 %, and on the 75th – by 0.83 % in comparison with the previous age. The 90th day of the study shows a significant ( $P \leq 0.05$ ) increase of the LOOH (LOPs) content in the longest back muscle tissues by 6.3 % in comparison with the 75 day old animals.

It should be noted that the content of TBARS – products in the rabbit brain decreases with the age, indicating the glutathione link activation of the organism antioxidant protection system (Fig. 2).

Moreover, the tissue specific formation of lipid peroxide oxidation products has been noticed. Thus, the highest content of them is observed in brain throughout the study period whereas the longest spinal muscle has the lowest LOOH (LOPs) content. The inconsistent change in the TBARS-products of the reactive substance content with hydroperoxides happens due to the fact that these products are formed from LOOH (LOPs), which can be re-oxidized and neutralized with glutathione and glutathione peroxidase.

In the brain tissues of the experimental animals the fluctuations are observed in the content of conjugated dienes at the level of 1.63-2.08 mmol / g tissue (Fig. 3). From birth to 45 days, the content of conjugated dienes significantly ( $P \leq 0.05$ )

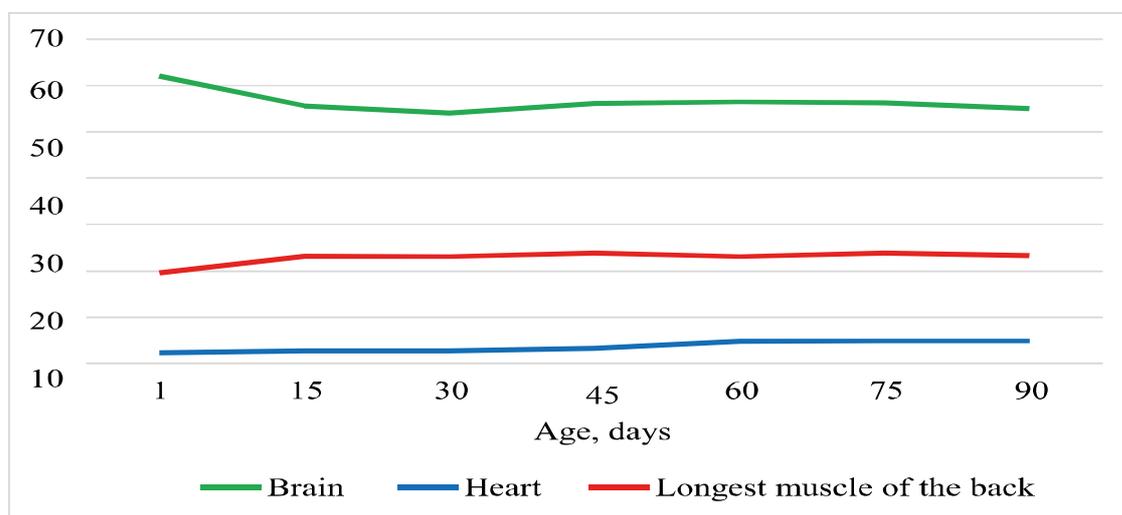


Figure 2. Content of TBARS-product substances in organs and tissues of rabbits, mmol / g tissue ( $M \pm m$ ,  $n = 5$ ).

Thus, on the 15th day of the rabbit life, the content of TBARS-products decreases ( $P \leq 0.05$ ) by 10.5 % in relation to one day-old rabbits. Later, a notable decrease of TBARS-product substance content is observed in the brain tissues as well. At the end of the study, their content significantly has decreased by 11.4 % in comparison with the beginning of the study. In the rabbit heart tissues, there is a significant ( $P \leq 0.05$ ) increase of TBARS-product content by 9.0 % on the 15th day of rabbit life in comparison with one day-old animals. During the whole period of study the TBARS-product substance constantly increases by 45.5 % on the 45th day, and by 2, 2 times on the 90th day in the heart tissues.

From the rabbit birth to the 90th day of their life the TBARS-product content probably increases by ( $P \leq 0.05$ ) in the longest back muscle. The 45 day-old rabbits have the highest content of it that is by (21.5 %) higher than one-day-old rabbits have.

increases by 27.6 %. Subsequently, the conjugated diene content decreases, but it exceeded indices of one day-old rabbits by 22.7 %.

In comparison with one day-old animals there is a significant increase of the content of conjugated dienes by 35.5 % in the heart of 45 day-old rabbits. However, at the end of the experiment, this indices decreases significantly ( $P \leq 0.05$ ) almost to the initial level. The lowest content of the conjugated dienes during the whole study period is observed in the longest back muscle. It has been noted that with age there is a tendency of the conjugated diene content decreasing in muscles, as well as in the heart of the rabbits. Thus, at the end of the experiment the content of conjugated dienes decreases by 23.5 %, relative to one day-old rabbits. Also, in the longest back muscle there is the lowest content of the conjugated dienes among other organs throughout the study period.

Discussion. Lipid peroxidation is closely connected with the lipid metabolism, which

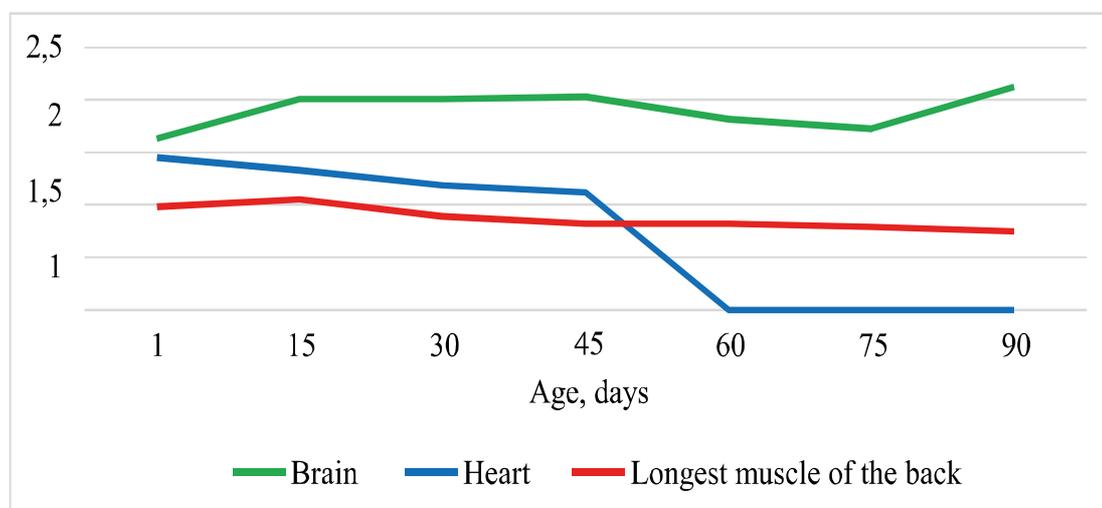


Figure 3. Content of conjugated dienes in organs and tissues of rabbits, mmol / mg tissue ( $M \pm m$ ,  $n = 5$ ).

reflects the universal response of cells to various stress factors [11, 14]. It determines the possibility of the membrane adaptive changes to transform in to the pathological ones [1, 6]. The intensity of the lipid peroxidation processes in the body is determined by the level of LOPs. The content of TBARS-product substance decreases from birth to 90 days in the rabbit brain. A moderate ( $r = 0.66$ ) correlation between conjugated dienes and lipid hydroperoxides has been established as well as a strong connection between conjugated dienes and TBARS-product substances. A moderate ( $r = -0.62$ ) correlation between conjugated dienes and lipid hydroperoxides is observed in the rabbit heart as well as a strong ( $r = -0.83$ ) correlation between conjugated dienes and superoxide dismutase activity.

In the rabbit brain the content of lipid peroxidation products increasing responses to physiological stress that is caused by its metabolic and functional activity. The highest content of phospholipids, polyunsaturated fatty acids,  $Fe^{2+}$ , cations has been found in the brain. The most part of the oxygen being used by the body is spent on brain processes, which facilitates the development of lipid peroxidation reactions [3, 5, 18].

**Conclusions.** It has been established that the processes of lipid peroxidation during the postnatal ontogeny have different intensity in the rabbit organism, with the highest content of lipid hydroperoxides in the brain tissue. Processes of protein oxidative modification also occur in the brain with greater intensity. A negative correlation between the content of lipid hydroperoxides and TBARS-product substances in brain tissues has been found as well as between the content of conjugated dienes, lipid hydroperoxides and superoxide dismutase activity in rabbit heart. A positive correlation between the glutathione

peroxidase activity, the content of TBARS-product substances and glutathione-S-transferase has been found in the brain as well as the content of lipid hydroperoxides. Therefore, the study results have shown that in the rabbit body the main oxidative stress target is the brain, which is worth controlling during the body antioxidant protection stimulation.

The research complies to the principles of bioethics, legislation and requirements under the provisions of the «European Convention for the Protection of Vertebrate Animals used for Research and Scientific Purposes» (Strasbourg, 1986) and the «General Ethical Principles for Experiments on Animals», approved by the First National Congress of bioethics (Kyiv, 2001).

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#### **Пероксидаційні процеси в організмі кролів у період постнатального онтогенезу**

**Роль Н.В., Цехмістренко С.І., Вовкогон А.Г., Поліщук В.М., Поліщук С.А., Пономаренко Н.В., Федорченко М.М.**

Однією з актуальних проблем біохімії є адаптація організму тварин до умов навколишнього середовища та формування адаптивної реакції на негативний вплив виробничих стрес-чинників. Серед таких адаптивних механізмів, для кролів в умовах інтенсивного ведення кролівництва, є розвиток оксидативного стресу, що спричинює накопичення в організмі активних форм Оксигену та, унаслідок цього, розвиток вільнорадикальної патології.

Важливе значення у механізмі адаптації організму належить ліпідам, оскільки вони є структурним компонентом клітинних мембран та виконують функцію енергетичних і сигнальних систем у клітинах. Пероксидне окиснення ліпідів – компенсаторна реакція, що забезпечує функціонування організму за зміни середовища існування.

Досліджено вміст загальних ліпідів та продуктів їх пероксидного окиснення, а також активність ензимів системи антиоксидантного захисту в організмі кролів від народження до 90-добового віку. Установлено, що в тканинах мозку вміст загальних ліпідів зростає упродовж усього періоду постнатального онтогенезу, що зумовлено особливостями функціональної та метаболічної актив-

ності клітин головного мозку. Уміст загальних ліпідів пов'язаний з процесами пероксидного окиснення ліпідів та активністю ензимів антиоксидантного захисту. Зростання концентрації продуктів пероксидного окиснення супроводжується зниженням умісту загальних ліпідів у тканинах серця кролів. Під час дослідження відмічено зменшення вмісту ТБК-активних продуктів у тканинах мозку кролів від народження до 90-добового віку. Крім того, встановлено помірний ( $r=0,66$ ) кореляційний зв'язок між умістом дієнових кон'югатів та гідропероксидів ліпідів, а також обернений значний ( $r=-0,77$ ) між вмістом дієнових кон'югатів та ТБК-активних продуктів. У серці кролів відмічено обернений помірний ( $r=-0,62$ ) кореляційний зв'язок між вмістом дієнових кон'югатів та гідропероксидів ліпідів.

**Ключові слова:** кролі, розвиток, пероксидне окиснення ліпідів, мозок, серце, найдовший м'яз спини.

#### Пероксидационные процессы в организме кроликов в период постнатального онтогенеза

Роль Н.В., Цехмистренко С.И., Вовкогон А.Г., Полищук В.Н., Полищук С.А., Пономаренко Н.В., Федорченко М.Н.

Одной из актуальных проблем биохимии является адаптация организма животных к условиям окружающей среды и формирование адаптивной реакции на негативное влияние производственных стресс-факторов. Среди таких адаптивных механизмов, для кроликов в условиях интенсивного ведения кролиководства, является развитие оксидативного стресса, что вызывает накопление в организме активных форм Кислорода и, как следствие, развитие свободнорадикальной патологии.

Важное значение в механизме адаптации организма принадлежит липидам, поскольку они являются структурным компонентом клеточных мембран и выполняют функцию энергетических и сигнальных систем в клетках. Перекисное окисление липидов – компенсаторная реакция, обеспечивающая функционирование организма в условиях изменения среды обитания.

Исследовано содержание общих липидов и продуктов их окисления, а также активность ферментов системы антиоксидантной защиты в организме кроликов от рождения до 90-суточного возраста. Установлено, что в тканях мозга содержание общих липидов возрастает в течение всего периода постнатального онтогенеза, что обусловлено особенностями функциональной и метаболической активности клеток головного мозга. Содержание общих липидов связано с процессами перекисного окисления липидов и активностью ферментов антиоксидантной защиты. Рост концентрации продуктов перекисного окисления сопровождается снижением содержания общих липидов в тканях сердца кроликов. В процессе исследования отмечено уменьшение содержания ТБК-активных продуктов в тканях мозга кроликов от рождения до 90-суточного возраста. Кроме того, установлено умеренную ( $r=0,66$ ) корреляционную связь между содержанием диєнових кон'югатів та гідроперекисей ліпідів, а также обратную значительную ( $r = -0,77$ ) между содержанием диєнових кон'югатів та ТБК-активних продуктів. В сердце кроликов отмечено обратную умеренную ( $r = -0,62$ ) корреляционную связь между содержанием диєнових кон'югатів та гідроперекисей ліпідів.

**Ключевые слова:** кролики, развитие, перекисное окисление липидов, мозг, сердце, длиннейшая мышца спины.



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ROL N., <https://orcid.org/0000-0003-0295-4193>  
TSEKHMISTRENKO S., <https://orcid.org/0000-0002-7813-6798>  
VOVKOGON A., <https://orcid.org/0000-0002-0521-2737>  
POLISHCHUK V., <https://orcid.org/0000-0002-0602-6100>  
POLISHCHUK S., <https://orcid.org/0000-0001-6716-848X>  
PONOMARENKO N., <https://orcid.org/0000-0002-2256-4929>

