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FATTY ACID COMPOSITION OF TISSUE LIPIDS GOSLINGS AND GOOSE EMBRYONS

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The changes in the fatty acid composition of the lipid in the brain tissues and geese liver and their embryos from 22-th embryonic day until 14-th day of postnatal period have been investigated. The fatty acid composition of tissues was quantified by methods of gas-liquid chromatography. The index of fatty acids unsaturation was calculated as equivalent concentration of unsaturated fatty acids relative to double bonds. Experience has shown that in the brain of geese high content of unsaturated fatty acids and level of their unsaturation occurs in 22-day-old embryos. From the 22nd to 28th day of embryogenesis the total content of unsaturated fatty acids in the brain tissues of embryos has decreased by 37.3 %, and the level of unsaturation of fatty acids — by 44.4 %. The transition to postnatal development (from the 28th day of embryogenesis to 1st day of postnatal period) was characterized by a stable content of unsaturated fatty acids in the brain. However, the degree of unsaturation of fatty acids has decreased by 8.0 %. The content of unsaturated fatty acids in the liver of 22-days embryos compared with the brain tissues was higher by 13.9 %, while the level of unsaturation fatty acids in the liver, as compared with the brain was lower by 17.8 %. From the 22nd day of embryogenesis to the 1st day of postnatal development gradual increase in the content of unsaturated fatty acids in the liver was traced, while the level of their unsaturation in this period remained unchanged.

A high content of unsaturated fatty acids was found in the liver of 1 day-old goslings, which is 15.8 % higher than the corresponding figure 22 day-old embryos. The first week of postnatal development was characterized by decrease in the content of unsaturated fatty acids in the liver by 25.0 %, and their level of unsaturation — by 21.62 %. The study results showed that one of the mechanisms of prooxidant-antioxidant balance support within the transition from of embryogenesis to postnatal development is to reduce the unsaturation of lipid fatty acids. This mechanism is realized in the brain of geese from hatching eggs of different quality. The support prooxidant-antioxidant balance in the liver by means of reducing the unsaturation of fatty acids is less effective and is mostly defined by fatty acid composition of lipids of geese hatching eggs.

Keywords: POLYUNSATURATED FATTY ACIDS, LIPIDS, ANSERIFORMES, BRAIN, LIVER, ONTOGENESIS, FATTY ACID COMPOSITION

ЖИРНОКИСЛОТНИЙ СКЛАД ЛІПІДІВ ТКАНИН ГУСЯТ І ГУСИНИХ ЕМБРІОНІВ

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Досліджено зміни жирнокислотного складу ліпідів тканин мозку і печінки гусей та їхніх ембріонів з 22-ї доби ембріогенезу до 14-ї доби постнатального періоду. Жирнокислотний склад тканин визначали методом газорідинної хроматографії. Індекс ненасиченості жирних кислот рахували як сумарну еквівалентну концентрацію ненасичених жирних кислот відносно подвійних зв'язків. Встановлено, що в мозку гусей найвищий вміст ненасичених жирних кислот та індекс їхньої *ненасиченості спостерігається в 22-добових ембріонів. Від 22- до 28-ї доби ембріогенезу сумарний вміст ненасичених жирних кислот ліпідів тканин мозку ембріонів зменшився на 37,3 %, а індекс їхньої ненасиченості — на 44,4%. Перехід до постнатального розвитку (з 28-ї доби ембріогенезу до першої доби постнатального періоду) характеризувався сталим вмістом ненасичених жирних кислот у мозку. Водночас ненасиченість жирних кислот зменшилася на 8,0 %. Порівняно з тканинами мозку, вміст ненасичених жирних кислот у тканинах печінки 22-добових ембріонів був вищий на 13,9 %, а індекс ненасиченості жирних кислот печінки, навпаки — нижчий на 17,8 %. З 22-ї доби ембріогенезу до 1-ї доби постнатального розвитку встановлено поступове зростання вмісту ненасичених жирних кислот у печінці, але індекс їхньої ненасиченості в цей період залишався незмінним. У печінці 1-добових гусенят встановлено найвищий вміст ненасичених жирних кислот, який на 15,8% перевищує відповідний показник 22-добових ембріонів. Перший тиждень постнатального розвитку характеризувався зниженням вмісту ненасичених жирних кислот у печінці на 25,0 %, а індексу їхньої ненасиченості — на 21,62 %. Результатами досліджень доведено, що в тканинах мозку одним із механізмів підтримки прооксидантно-антиоксидантної рівноваги під час переходу від ембріонального до постнатального розвитку є зниження ненасиченості жирних кислот ліпідів. Цей механізм реалізується в мозку гусей за різної якості інкубаційних яєць. У печінці, на відміну від мозку, підтримка прооксидантно-антиоксидантної рівноваги шляхом зниження ненасиченості жирних кислот менш дієва і більшою мірою визначається жирнокислотним складом ліпідів інкубаційних яєць гусей.*

Ключові слова: ПОЛІНЕНАСИЧЕНІ ЖИРНІ КИСЛОТИ, ЛІПІДИ, ГУСЕПОДІБНІ, МОЗОК, ПЕЧІНКА, ОНТОГЕНЕЗ, ЖИРНОКИСЛОТНИЙ СКЛАД

ЖИРНОКИСЛОТНЫЙ СОСТАВ ЛИПИДОВ ТКАНЕЙ ГУСЯТ И ГУСИНЫХ ЭМБРИОНОВ

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Исследованы изменения жирнокислотного состава липидов тканей мозга и печени гусей и их эмбрионов с 22-х суток эмбриогенеза до 14-х суток постнатального периода. Жирнокислотный состав тканей определяли методом газожидкостной хроматографии. Индекс ненасыщенности жирных кислот рассчитывали как суммарную эквивалентную концентрацию ненасыщенных жирных кислот относительно двойных связей. Установлено, что в мозге гусей самое высокое содержание ненасыщенных жирных кислот и индекс их ненасыщенности наблюдается в 22-суточных эмбрионов. С 22-х до 28-х суток эмбриогенеза суммарное содержание ненасыщенных жирных кислот в тканях мозга эмбрионов уменьшилось на 37,3 %, а индекс их ненасыщенности — на 44,4 %. Переход к постнатальному развитию (с 28-х суток эмбриогенеза до 1-х суток постнатального периода) характеризовался стабильным содержанием ненасыщенных жирных кислот в мозге. Одновременно ненасыщенность жирных кислот уменьшилась на 8,0 %. Содержание ненасыщенных жирных кислот в тканях печени 22-суточных эмбрионов, по сравнению с тканями мозга, было выше на 13,9 %, а индекс ненасыщенности жирных кислот печени — наоборот, ниже на 17,8 %. С 22-х суток эмбриогенеза до 1-х суток постнатального развития установлен постепенный рост содержания ненасыщенных жирных кислот в печени, но уровень их ненасыщенности в этот период оставался неизменным. В печени 1-суточных гусят установлено высокое содержание ненасыщенных жирных кислот, которое на 15,8 % превышает соответствующий показатель 22-суточных эмбрионов. Первая неделя постнатального развития характеризовалась снижением содержания ненасыщенных жирных кислот в печени на 25,0 %, а индекса их ненасыщенности — на 21,62 %. Результатами исследований доказано, что в тканях мозга одним из механизмов поддержки прооксидантно-антиоксидантного равновесия при переходе от эмбрионального к постнатальному развитию является снижение ненасыщенности жирных кислот липидов. Этот механизм реализуется в мозге гусей, выведенных из инкубационных яиц *разного качества. В отличие от мозга, в печени поддержка прооксидантно-антиоксидантного равновесия путем снижения ненасыщенности жирных кислот менее еффективна и в большей степени определяется жирнокислотным составом липидов инкубационных яиц гусей.*

Ключевые слова: ПОЛИНЕНАСЫЩЕННЫЕ ЖИРНЫЕ КИСЛОТЫ, ЛИПИДЫ, ГУСЕПОДОБНЫЕ, МОЗГ, ПЕЧЕНЬ, ОНТОГЕНЕЗ, ЖИРНОКИСЛОТНЫЙ СОСТАВ

It is known that changes in physiological functions occur after the hatching of birds in the period of adaptation to the new conditions in an oxygen environment. In the postnatal period in the conditions of industrial poultry keeping the natural conditions of existence change fundamentally, that leads to disturbed physiological and biochemical homeostasis in the body, the intensification of lipid peroxidation (LPO), changes in the composition of the main substrate of lipid peroxidation of fatty acid (FA) [1]. The selection of fabrics is determined by a high maintenance of unsaturated lipids in the brain, which identifies it as a dominant substratum for the LPO processes. High content of unsaturated lipids is inherent to brain tissues of birds, and the brain is actively provided by oxygen and includes a wide range of enzymes that generate reactive oxygen species (ROS). In the process of lipid metabolism the liver plays an important role [2], there is elongation and reduction of carbon chain of fatty acids, their dehydrogenation, β-oxidation and other lipid metabolism [3]. Thus, the aim of this study was to determine the changes in the composition of fatty acids in the brain and liver of geese and their embryos during the transition from embryonic to postnatal development.

Materials and methods

For the incubation geese eggs by breed «large white» with an average weight (150.52±7.53) g were selected. Research of fatty acid composition in embryogenesis were performed in a physiologically acceptable conditions: 22 days — the transition from the food protein type to the yolk one, the embryo transfer output has taken 28 days. In postnatal period the studies were limited to 14 days of age (postnatal adaptation period) [4]. The objects of the study were the brain tissue and liver.

The work was conducted in accordance with the «General ethical principles of animal experiments» (Ukraine, 2001), in accordance with the provisions of the «European Convention for the Protection of vertebrate animals used for experimental and other scientific purposes» (Strasbourg, 1985).

Embryos and goslings were decapitated according to the experimental plan. Selected tissues were washed after decapitation in the saline and homogenized in 50 mM phosphate buffer (pH = 7.4). Lipid extracts were prepared by the method of E. G. Bligh and W. I. Dyer [5] with the recommendations of F. B. Palmer [6]. Fatty acid composition was determined in lipid extract by gas-liquid chromatography on chromatograph Carlo Erba (Italy) with glass columns. Chromosorb W/DP with 10 % phase Silar 5CP («Serva», Germany) was used as a carrier in conditions of programmable temperature 140–250 °C, 2 °C/min. (injector temperature 210 °C, temperature of detector 240 °C). Index of unsaturation of fatty acid (N_{Σ}) considered equivalent to the total concentration of unsaturated fatty acids (UFA) relative to the double bonds [7]. Mathematical processing of the experimental data was performed by using multivariate statistical analysis, using software packages MS Excel 2003.

Results and discussion

The hatch of birds can be regarded as a physiological stress associated with increasing by partial pressure of oxygen in the transition to pulmonary respiration. [8]. This transition is accompanied by a significant increasing in metabolic activity of tissues and, in particular, the intensification of lipid peroxidation [9], because it absorbs lipids from the yolk membrane yolk sac and during embryonic development of birds it is characterized by a high degree of unsaturation. Polyunsaturated fatty acids perform important functions in the body, but also the increasing of them in the tissues leads to increased sensitiveness of poultry tissues to lipid peroxidation [10].

The experimental results have shown that the highest content of UFA and their level of unsaturation is observed in the brain of 22-day-old geese embryos (table 1). In this age a higher content among the UFA have an oleic (18:1) and polyunsaturated arachidonic (20:4), docosapentaenoic (22:5) acids, and among the saturated ones palmitic (16:0) and stearic (18:0) acids are predominant. From 22 to 28 days of embryogenesis total lipid content of brain tissue UFA embryos decreased by 37.3 %, while the level index of unsaturation of fatty acid — 44.4 %. These changes were caused by decreasing of docosapentaenoic acid, and to a lesser extent — an oleic acid.

The transition to postnatal development (from the 28-th day of embryogenesis in the first postnatal period) was characterized by a permanent content of UFA. However, index of unsaturation of fatty acid decreased by 8.0 %. The results differ significantly from those previously published: content UFA (27.5 %) and unsaturated (93.2 %) in the brain 1-day goslings [1]. Primarily, this significant difference may be due to different proportions of green feed in the diet of geese breeder [11], as well as their characteristics of the breed.

Differences of fatty acid composition (FAC) of geese brain are likely to lead to different resistance to diseases associated with birds cell damage by free radicals, because the UFA is the main substrate of lipid peroxidation [12, 13]. Nevertheless, the overall dynamics of the brain FAC embryos geese at the end of the embryonic period, characterized by low levels index of unsaturation of fatty acid is confirmed. Thus, the reduction of unsaturated lipids in brain tissue is likely to be genetically programmed preparation embryos to postnatal conditions of existence [9].

The starting of postnatal adaptation was accompanied by an increase in the content of the UFA to 23.5 %, and their level of unsaturation — 20.6 % due to increased oleic (18:01) and docosapentaenoic (22:05) acids (fig. 1).

Compared with the brain tissues, the content in the liver tissue of the UFA at 22-day-old embryos was higher by 13.9 %. Growth of this index is mainly due to increasing of oleic and linoleic acids (18:2), and to a lesser extent of linolenic (18:3) and dokozatrienoic (22:3) acids (table 2). The index of unsaturation of fatty acid liver 22-day-old embryos as compared to the brain, however, is lower by 17.8 %.

In the late embryonic period (from the 22nd day of embryogenesis to the 1st day of postnatal development), there was a gradual increase in the content index of unsaturation of fatty acids due to increasing of linolic (18:02), linolenic (18:03) and dokozatrienoic (22:3) acids, but the level index of unsaturation of fatty acids in this period remained unchanged. A high content of the UFA has been discovered in the liver of the 1-day-old goslings, which is 15.8 % higher than the corresponding figure of 22-day-old embryos (fig. 2).

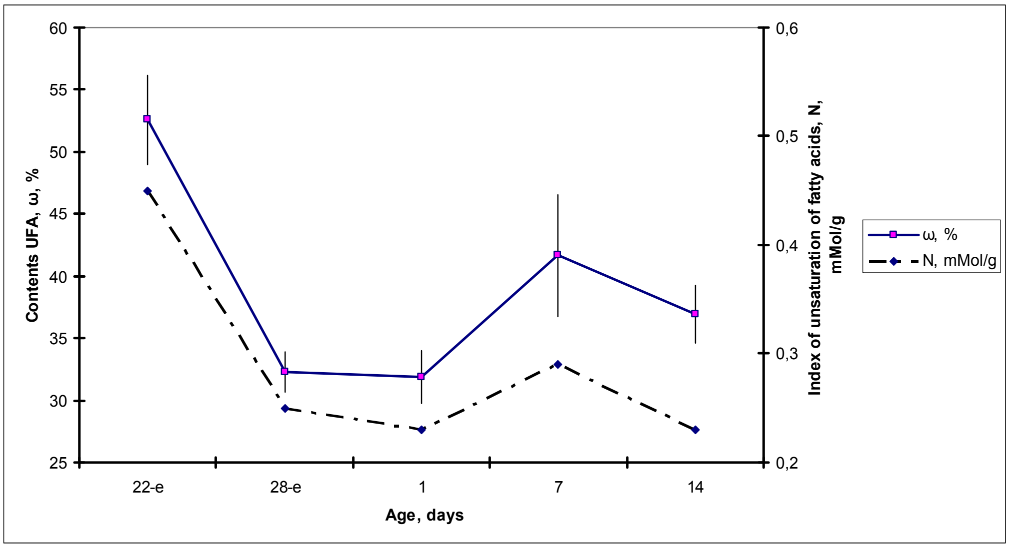

Fig. 1. The changes in the content and level index of unsaturation of fatty acid in brain tissues (ω, %, N, Mmol/g)

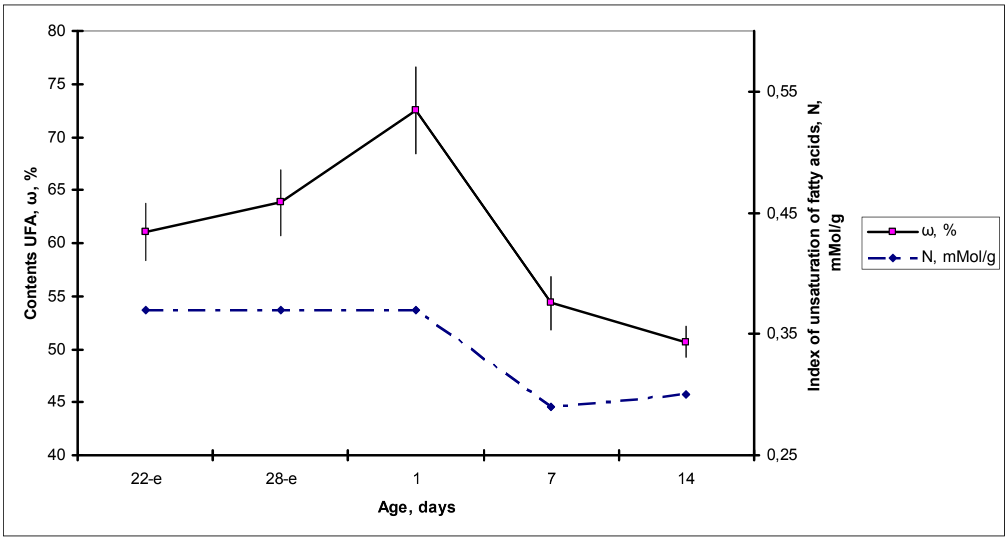

Fig. 2. The changes in the content and level of their index of unsaturation of fatty acid in liver tissues (ω, %, N, Mmol/g)

However, index of unsaturation of fatty acid liver during fetal life has remained at a constant level. Despite some differences that we have received of the liver lipid FAC dynamics and previously published data [14], the main fact is that in the end of embryogenesis, inhibition of lipid peroxidation process by reducing the levels of unsaturated lipids in the liver tissue was less pronounced than in the brain.

Table 1

Fatty acid composition of brain tissue in goose embryos and goslings (M ± m, n=6)

Acids	22-day embryos		28-day embryos		1 postnatal day		7 postnatal day		14 postnatal day	
	ω	N	ω	N	ω	N	ω	N	ω	N
12:1	0.01 ± 0.00	0.00	0.11 ± 0.01	0.00			0.37 ± 0.01	0.00	0.15 ± 0.01	0.00
14:0	0.80 ± 0.02	0.00	0.56 ± 0.02	0.00	0.48 ± 0.01	0.00	0.54 ± 0.02	0.00	0.27 ± 0.00	0.00
16:0	23.52±0.87	0.00	39.06±1.56	0.00	37.39±1.11	0.00	24.25±0.66	0.00	26.84±1.01	0.00
16:1	2.77±0.06	0.01	1.75±0.01	0.01	1.64±0.01	0.01	2.03±0.26	0.01	1.47±0.04	0.01
18:0	18.04±0.63	0.00	23.32±0.34	0.00	25.13±0.71	0.00	23.65±0.71	0.00	27.09±0.88	0.00
18:1	19.75±0.76	0.07	15.43±0.26	0.05	17.81±0.53	0.06	21.78±0.72	0.08	22.19±0.52	0.08
18:2	1.05±0.03	0.01	0.64±0.01	0.00	0.44±0.00	0.00	0.79±0.13	0.01	1.33±0.06	0.01
18:3							0.03±0.01	0.00		
20:0	0.14 ± 0.01	0.00	0.45 ± 0.00	0.00	0.28 ± 0.02	0.00	0.39 ± 0.00	0.00	0.39 ± 0.01	0.00
20:1	0.32 ± 0.00	0.00	0.41 ± 0.02	0.00	0.56 ± 0.01	0.00	0.86 ± 0.13	0.00	0.73 ± 0.02	0.00
21:0	0.26 ± 0.01	0.00	0.18 ± 0.00	0.00	0.33 ± 0.02	0.00	1.14 ± 0.04	0.00	0.69 ± 0.01	0.00
20:3							0.27±0.12	0.00	0.08±0.00	0.00
20:4	12.69±0.45	0.17	11.19±0.15	0.15	6.75±0.07	0.09	6.75±0.13	0.09	4.09±0.05	0.05
22:0	0.11±0.01	0.00	0.73±0.02	0.00	1.44±0.07	0.00	1.44±0.02	0.00	1.74±0.05	0.00
22:1	0.02±0.00	0.00			0.08±0.00	0.00	0.26±0.01	0.00	0.28±0.00	0.00
22:3	0.09±0.00	0.00	0.12±0.00	0.00	0.09±0.00	0.00	0.45±0.05	0.00	0.30±0.01	0.00
24:0	2.36±0.07	0.00	1.03±0.02	0.00	1.88±0.03	0.00	2.37±0.08	0.00	1.01±0.03	0.00
24:1	2.48±0.09	0.01	0.41±0.01	0.00	0.55±0.01	0.00	1.47±0.34	0.00	2.03±0.07	0.01
22:5	12.31±0.52	0.19	1.85±0.02	0.03	3.86±0.04	0.06	5.74±0.17	0.09	4.08±0.07	0.06
22:6							0.02±0.00	0.00		
Content UFA	**52.59**	**0.45**	**32.27**	**0.25**	**31.89**	**0.23**	**41.68**	**0.29**	**36.92**	**0.23**

Note: content UFA (*ω, %*); index of unsaturation of fatty acids *(N, mMol/g)*

Table 2

Fatty acid composition of liver tissues in goose embryos and goslings (M ± m, n=6)

Acids	22-day embryos		28-day embryos		1 postnatal day		7 postnatal day		14 postnatal day	
	ω	N	ω	N	ω	N	ω	N	ω	N
12:1	0.06±0.00	0.00	0.03±0.00	0.00	0.18±0.00	0.00	0.04±0.00	0.00	0.04±0.00	0.00
14:0	0.21±0.01	0.00	0.28±0.00	0.00	0.26±0.01	0.00	0.55±0.01	0.00	0.40±0.01	0,00
16:0	20.61±0.44	0.00	17.55±0.39	0.00	14.75±0.26	0.00	27.16±0.73	0.00	24.46±0.78	0.00
16:1	2.13±0.07	0.01	4.40±0.15	0.02	2.36±0.06	0.01	3.79±0.01	0.01	1.68±0.01	0.01
18:0	15.66±0.24	0.00	14.86±0.45	0.00	9.99±0.13	0.00	16.18±0.56	0.00	21.06±0.65	0.00
18:1	37.58±1.15	0.13	34.22±1.28	0.12	52.23±1.87	0.18	34.35±1.24	0.12	30.65±0.56	0.11
18:2	7.27±0.22	0.05	13.24±0.35	0.09	7.66±0.19	0.05	7.50±0.09	0.05	7.19±0.04	0.05
18:3	0.22±0.00	0.00	0.42±0.00	0.00	0.27±0.01	0.00	0.07±0.00	0.00	0.09±0.00	0.00
20:0	0.16±0.00	0.00	0.30±0,00	0.00	0.22±0.01	0.00	0.21±0.00	0.00	0.47±0.00	0.00
20:1	0.35±0.00	0.00	0.84±0.01	0.00	0.43±0.27	0.00	0.46±0.01	0.00	0.56±0.01	0.00
21:0	0.46 ± 0.01	0.00	0.48 ± 0.01	0.00	0.17 ± 0.00	0.00	0.29 ± 0.00	0.00	0.88 ± 0.02	0.00
20:3									0.55±0.00	0.01
20:4	10.88±0.17	0.14	8.41±0.18	0.11	7.93±0.24	0.10	7.25±0.02	0.10	8.88±0.11	0.12
22:0	0.43±0.00	0.00	0.30±0.00	0.00	0.45±0.01	0.00	0.51±0.01	0.00	0.86±0.01	0.00
22:1			0.08 ± 0.00	0.00						
22:3	0.16±0.00	0.00	0.23±0.01	0.00	0.17±0.00	0.00	0.10±0.00	0.00	0.19±0.00	0.00
24:0	0.58±0.01	0.00	0.68±0.01	0.00	0.25±0.00	0.00	0.20±0.00	0.00	0.34±0.01	0.00
24:1	0.18±0.00	0.00	025±0.00	0.00	0.20±0.00	0.00	0.19±0.00	0.00	0.31±0.01	0.00
22:5	2.06±0.05	0.03	1.12±0.03	0.02	0.71±0.35	0.01	0.41±0.01	0.01	0.50±0.01	0.01
22:6			0.14±0.00	0.00						
Content UFA	**61.07**	**0.37**	**63.84**	**0.37**	**72.51**	**0.37**	**54.35**	**0.29**	**50.70**	**0.30**

Note: content UFA *(ω, %);* index of unsaturation of fatty acids *(N, mMol/g)*

The first week of postnatal development is characterized by a rapid decrease in the content of the UFA — 25.0 %, and their level unsaturation — by 21.62 %, it is well known that the first feeding is the activation factor of lipid metabolism in the body after hatching birds, after it hepatoenteral lipid transport in the liver during embryonic development is amplified which helps to reduce the content of the UFA in the first week of goslings life [15].

Conclusions

Thus, the support mechanisms in the brain prooxidant-antioxidant balance in the transition from fetal to postnatal development is the reduction index of unsaturation of fatty acid lipids. This mechanism is implemented in the brain due to a different quality of hatching geese eggs. Unlike the brain the support of provident-antioxidant balance in the liver by reducing the unsaturation FA is less effective and largely determined by FAC lipids of hatching geese eggs.

Prospects for further research. In recent years proved crucial role of fatty acids in cellular activity of any animal organism. However, the question of violation of the fatty acid composition and their functional role in conditions of oxidative stress studied not enough. Therefore, the study of the dynamics of the fatty acid composition of the body of birds at different levels of its structural organization will contribute to the elucidation of the mechanisms of adaptation and compensation imbalance of fatty acids in biological structures bird's body. In practical terms, the elucidation of the mechanisms of formation of adaptive response to oxidative stress contribute to optimization of process conditions and feeding poultry.

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