DOI 10 26724/2079-8334-2023-3-85-209-215
UDC 311.018.616.23/.24.599.323.4:641

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MORPHOMETRIC AND MORPHOLOGICAL FEATURES OF RAT BRONCHUS-ASSOCIATED LYMPHOID TISSUE UNDER THE IMPACT OF THE COMPLEX OF FOOD ADDITIVES

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The paper presents the results of a morphometric and morphological study of the broncho-associated lymphoid tissue of the lungs of rats under the complex action of food additives. It was established that the use of a complex of monosodium glutamate, sodium nitrite and Ponceau 4R leads to a change in morphometric indicators, due to the occurrence of local protective barrier tension phenomena, which was expressed by the formation of secondary lymphoid follicles in the composition of broncho-associated lymphoid tissue, with wave-like changes in cellular representation, which reflected the process antigen-dependent differentiation of immune cells, which was confirmed by an increase in the number of lymphocytes against the background of a decrease in plasma cells and vice versa, and an expansion of the lumen of the vessels of the microcirculatory bed, due to the migration of immunocompetent cells due to the constant and long-term action of a non-specific factor formed by the components of the complex of food additives.

Key words: food additives, broncho-associated lymphoid tissue, microcirculatory bed, lymphocytes, plasma cells, macrophages, lungs, rats.

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МОРФОМЕТРИЧНІ ТА МОРФОЛОГІЧНІ ОСОБЛИВОСТІ БРОНХОАСОЦІЙОВАНОЇ ЛІМФОЇДНОЇ ТКАНИНИ ЩУРІВ ПІД ДІЄЮ КОМПЛЕКСУ ХАРЧОВИХ ДОБАВОК

В роботі представлені результати морфометричного та морфологічного дослідження бронхоасоційованої лімфоїдної тканини легень щурів при комплексній дії харчових добавок. Встановлено, що вживання комплексу глутамату натрію, нітриту натрію та Понсо 4R призводить до зміни морфометричних показників, внаслідок виникнення явищ напруженості місцевого захисного бар'єру, що виражалось утворенням вторинних лімфоїдних фолікулів у складі бронхоасоційованої лімфоїдної тканини, з хвилеподібними змінами клітинного представництва, яке відображало процес антиген-залежного диференціювання імунних клітин, що підтверджувалось збільшенням кількості лімфоцитів на фоні зниження плазматичних клітин і навпаки, та розширенням просвіту судин мікроциркуляторного русла, за рахунок міграції імунокомпетентних клітин внаслідок постійної та тривалої дії неспецифічного фактору утвореного складовими комплексу харчових добавок.

Ключові слова: харчові добавки, бронхоасоційована лімфоїдна тканина, мікроциркуляторне русло, лімфоцити, плазмоцити, макрофаги, легені, щури.

The paper has been written within the research scientific work "Restructuring of the organs of the immune, respiratory and excretory systems under the effect of various exogenous factors (monosodium glutamate, sodium nitrite, ethanol, methacrylate)", State Registration No 0121U108234.

Recently, the high rates of lung damage has been explained by the theory of the so-called "first filter." According to this theory, activated blood cells, toxins, and inflammatory mediators primarily enter the pulmonary capillaries, making the lungs one of the first target organs to undergo aggressive action. This leads to disturbances in the microcirculation and damage to the organ's parenchyma, ultimately resulting in the development of interstitial and alveolar edema [10]. Bronchus-associated lymphoid tissue is most often found in the anterior rather than the posterior parts of the lungs and is located beneath the bronchial epithelium. In bronchioles, it is commonly localized adjacent to arterioles. Lymphoid follicles and unorganized aggregations of lymphocytes can also be detected in the lung tissue, which may be at various stages of differentiation. The primary function of bronchus-associated lymphoid tissue is to capture antigens entering the lungs and to generate local immunity against specific antigens [1].

Currently, a notable feature of modern food technologies is the use of food additives, which has sparked significant controversy primarily due to the lack of comprehensive research regarding their impact on the human body, especially in conditions where they interact synergistically [4]. When analyzing the content of food additives in products from both foreign and domestic manufacturers, it has been found that the most prevalent additives are monosodium glutamate, sodium nitrite and Ponceau 4R.

An overview of the potential health hazard of monosodium glutamate reports relationship between the consumption of monosodium glutamate and tumorigenesis, increased oxidative stress and apoptosis in thymocytes, as well as genotoxic effect in lymphocytes. A critical analysis of the existing literature

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indicates that many of the negative reports regarding the consequences of monosodium glutamate consumption for health are not very informative because they are based on excessive dosage that do not correspond to the levels typically consumed in food products [15].

Sodium nitrite can be found in many meat products. In the acidic medium of the stomach, sodium nitrite reacts with amines, forming nitrosamines, or with amides, forming nitrosamides. The carcinogenic potential of N-nitroso compounds has been demonstrated in experimental animals, but its relevance to humans is still debated [12]. Several studies on experimental animals investigate the effect of sodium nitrite in chronic therapy on pulmonary hypertension [8] and examine how the nebulization of an acidic sodium nitrite preparation attenuates acute hypoxic pulmonary vasoconstriction [6].

The Ponceau 4R food colorant belongs to the category of synthetic substances that, upon entering the body as haptens and binding to proteins such as serum albumin and others, become complete antigens, eliciting the synthesis of antibodies. Typically, the allowed sanitary and hygienic norms are exceeded, which enhances their allergenicity [11]. Therefore, a detailed analysis of all available scientific sources allows us to conclude that the study on the impact of complex of food additives on the respiratory system is quite limited and requires further comprehensive study.

The purpose of the study was to establish the dynamics of changes in morphometric parameters of the linear size of bronchus-associated lymphoid tissue with the diameter of the microcirculatory vessels' lumen within it, as well as changes in quantitative parameters of cellular representation under normal conditions and in response to the combined action of food additives, namely, monosodium glutamate, sodium nitrite and Ponceau 4R.

Materials and methods. 84 mature outbred male rats were involved into the study. The rats of control group (n=10) consumed drinking water and were administered with saline orally. The rats of the experimental group, with access to water ad libitum, were administered with 0,6 mg/kg sodium nitrite, 20 mg/kg monosodium glutamate and 5 mg/kg Ponceau 4R in 0.5 ml of distilled water once daily per os. Admittedly, the doses of food additives were twice lower than the allowable normal rate in food products. The "open field" test was used to evaluate the rats' adaptive behavior [13].

The animals were sacrificed within 1, 4, 8, 12 and 16 weeks under thiopentone anesthesia overdose. After animals' euthanasia, the fragments of the lungs were fixed in 10 % formalin solution. Subsequently, the pieces of the lungs were embedded into paraffin, using the conventional technique [10]. Sections of 5-10 μm thick were made using the ARM 3600 microtome. Semi-thin sections were obtained using the UMTP-7 ultramicrotome. After staining with hematoxylin and eosin the sections were placed in polystyrene and studied under the light microscope. The digital microscope, equipped with the Levenhuk D740T digital microphoto attachment, and adapted software have been used for microphotography and morphometric study. Statistical processing of morphometric data was performed using the Excel program [3].

All animal experiments were carried out in compliance with the requirements of the European Convention for the Protection of Vertebrate Animals used for Experimental and Scientific Purposes (Strasbourg, 1986), in accordance with the rules for keeping experimental animals established by European Parliament and Council Directive (2010/63/EU) and the Order №134 of the Ministry of Education and Science, Youth and Sports of Ukraine as of 01.03.2012, No. 249 "On approval of the procedure for conducting tests, experiments on animals by research institutions", as well as the recommendations of the First National Congress of Ukraine on Bioethics (2001).

Table 1

The dynamics of the rat bronchus-associated lymphoid tissue parameters

Parameters	"Linear size" (μm)	Plasma cells count (FOV)	Macrophage count (FOV)	Lymphocyte count (FOV)	Reticulocyte count (FOV)
Control	392.15±2.64	180.7±6.79	120.64±4.62	249.53±8.33	29.00±0.11
Week 1	680.56±4.69 *	321.79±5.79 *	123.18±5.35	109.53±7.67 *	20.80±0.09 *
Week 4	474.34±2.05 *,**	322.79±7.62 *	136.19±7.64 *,**	93.53±9.21 *,**	34.39±0.10 *,**
Week 8	292.36±1.68 *,**	107.79±2.00 *,**	172.19±1.51 *,**	392.53±1.55 *,**	28.40±0.08 *,**
Week 12	227.66±1.89 *,**	294.68±2.51 *,**	164.32±1.50 *,**	140.52±1.61 *,**	24.39±0.07 *,**
Week 16	357.81±7.85 *,**	284.68±3.44 *,**	144.32±3.71 *,**	128.52±2.36 *,**	22.38±0.17 *,**

Note* - P<0.05 compared to the control group; ** - P<0.05 compared to the previous time period of the observation.

Results of the study and their discussion. Bronchus-associated lymphoid tissue is located beneath the epithelium of large bronchi, in the submucosal layer of small bronchi. It has an ovoid shape with uneven

edges, and its base consists of reticular cells and fibers. The spaces between them are filled with lymphocytes, lymphoblasts, plasma cells, and macrophages. This tissue extends from the epithelium to the adventitia of bronchioles.

The morphometric study of rat bronchus-associated lymphoid tissue has found that the average linear size was 392.15±2.64 μm. The cell count within the lymphoid tissue revealed that the average number of reticulocytes was 29.00±0.11 FOV, plasma cells were 180.7±6.79 FOV, macrophages were 120.64±4.62 FOV, and the count of lymphocytes was 249.53±8.33 FOV (Table 1).

The histological study of rat lung specimens showed that clusters of bronchus-associated lymphoid tissue were found in the submucosal layer, predominantly surrounding the lumen of small bronchi, and exhibited a round, oval or irregular shape. The cytological composition was mainly comprised of lymphocytes and lymphoblasts. Lymphocytes were distributed diffusely or in aggregations, forming lymphoid follicles. The lymphoid tissue primarily consisted of primary lymphoid follicles rather than the secondary ones. In addition to lymphocytes, plasma cells and macrophages were also present, and the stroma was composed of reticular cells. The size and structure of bronchus-associated lymphoid tissue could vary depending on the morphofunctional state (Figs. 1, 2).

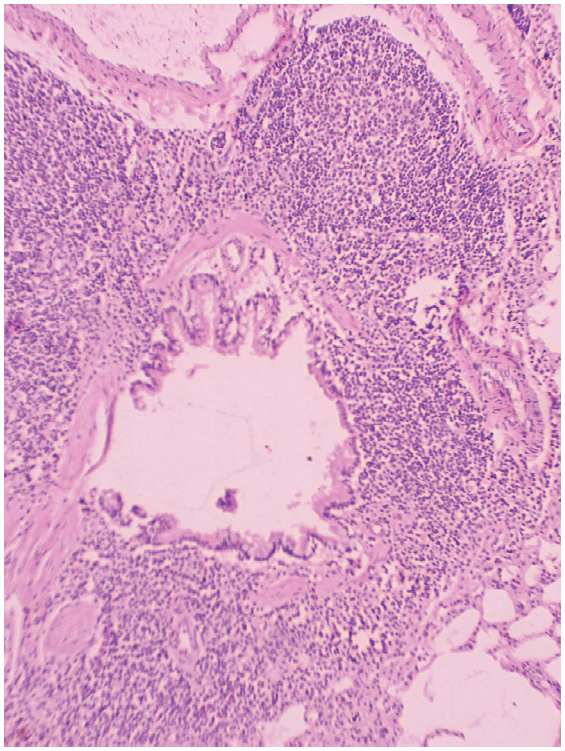

Fig. 1. Bronchus-associated lymphoid tissue in the wall of small bronchi in the control group of rats. H&E stain. Oc. lens: 10×magnification; ob. lens: 10× magnification.

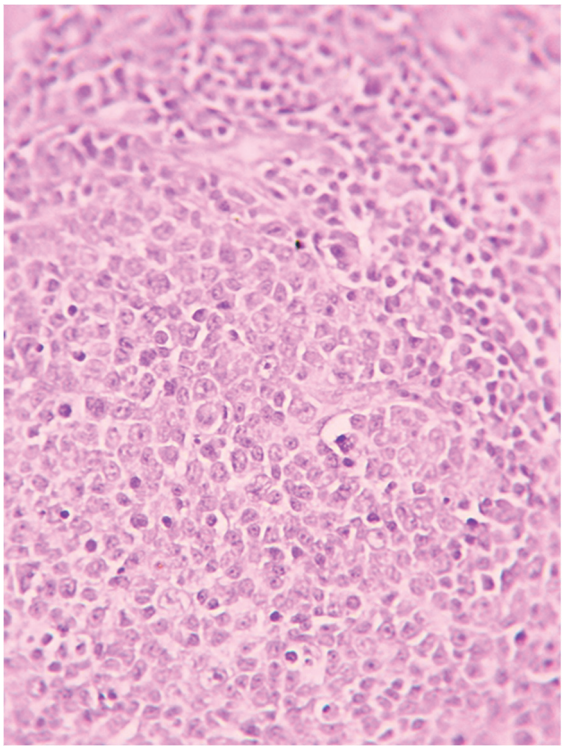

Fig. 2. The phenomenon of plasma cell hyperplasia in the bronchus-associated lymphoid tissue of the small bronchi of rats following one week of consuming the complex of food additives. H&E stain. Oc. lens: 10×magnification; ob. lens: 40× magnification.

Following one week of consumption of the complex of food additives, a significant increase in the average linear size by 73.55 % was observed, which accounted for 680.56±4.69 μm ($p<0.05$). The quantitative composition of cellular representation in the lymphoid tissue also changed: the number of reticulocytes decreased significantly by 1.39 times, with average values of 20.80±0.09 FOV. The plasma cells count significantly increased by 1.78 times and reached 321.79±5.79 FOV. The average number of macrophages increased by 1.02 times and did not significantly differ from the values in the control group, accounting for 123.18±5.35 FOV ($p<0.05$). However, the number of lymphocytes significantly decreased by 2.28 times, accounting for 109.53±7.67 FOV ($p<0.05$).

Microscopically, hyperplasia of the lymphoid tissue was observed, caused by an increase in plasma cells, which were present in focal aggregations and scattered diffusely among lymphoid cells. The specimens also showed dilatation of the capillary lumen.

Consumption of the complex of monosodium glutamate, sodium nitrite and Ponceau 4R on week 4 of the experiment resulted in a significant reduction in the average linear size by 30.30 % as compared to the previous time period, accounting for 474.34±2.05 μm. However, it was by 20.96 % significantly higher than the values in the control group ($p<0.05$). The quantitative count of the cellular composition of the bronchus-associated lymphoid tissue on week 4 showed a significant increase in the number of

reticulocytes by 1.65 times compared to the previous period, accounting for 34.39±0.10 FOV. This number was also by 1.19 times significantly higher compared to the control group ($p<0.05$). The average number of plasma cells did not significantly differ from the values of week 1, though it was by 1.79 times significantly higher the values in the control group, accounting for 322.79±7.62 FOV. The quantitative count showed an increase in the number of macrophages, accounting for 136.19±7.64 FOV, and it was by 1.11 times and 1.13 times significantly higher compared to the previous time period and the control group, respectively ($p<0.05$). On week 4, a decrease in the number of lymphocytes, with an average count of 93.53±9.21 FOV, was noted, which was by 1.17 times significantly lower compared to the previous values and by 2.67 times lower compared to the control group ($p<0.05$).

Consumption of the complex of food additives on week 8 of the experiment led to a significant reduction in the average linear size by 38.36 % compared to the previous time period, accounting for 292.36±1.68 μm. This value was also by 25.45 % significantly lower than the values in the control group ($p<0.05$). The average number of reticulocytes significantly decreased by 1.21 times compared to the previous time period of the experiment, accounting for 28.40±0.08 FOV, which was by 1.02 times significantly lower compared to the control group ($p<0.05$). The average number of plasma cells significantly decreased and accounted for 107.79±2.00 FOV, which was by 2.99 times lower than the values on week 4 of the experiment and by 1.68 times lower compared to the control group of rats ($p<0.05$).The average number of macrophages significantly increased by 1.26 times compared to the previous time period of the study and was by 1.43 times higher compared to the control group, accounting for 172.19±1.51 FOV ($p<0.05$).The number of lymphocytes accounted for 392.53±1.55 FOV, which was by 4.20 times significantly higher than their average values on week 8 of the experiment and by 1.57 times significantly higher compared to the control group ($p<0.05$).

In the broncho-associated lymphoid tissue, the signs of hyperplasia with an increase in the number of secondary follicles, primarily due to lymphoid cells, were noted. Plasma cells were observed in small quantities. Reticular cells were well-defined due to a decrease in plasma cells. The lumens of arterioles were dilated with the signs of plethora, endothelial cells were flattened and myocytes were elongated (Figs. 3, 4).

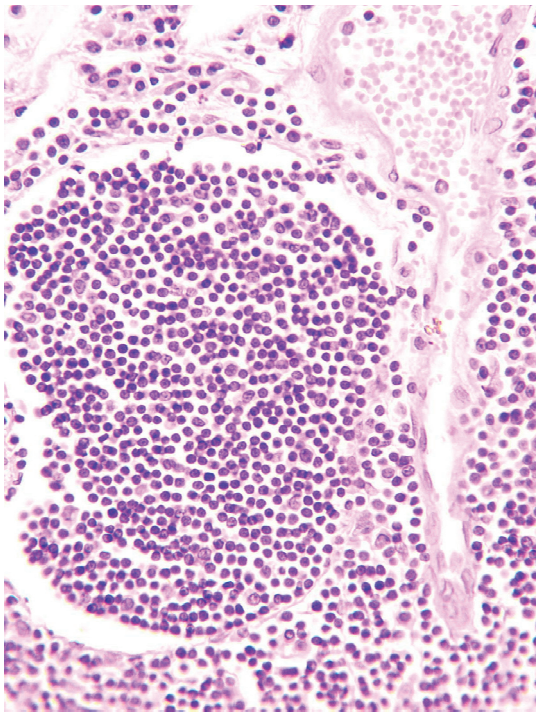

Fig. 3. Hyperplasia of lymphoid cells in the broncho-associated lymphoid tissue of rat small bronchi on week 8 of consumption of the complex of food additives. H&E stain. Oc. lens: 10×magnification; ob. lens: 40× magnification.

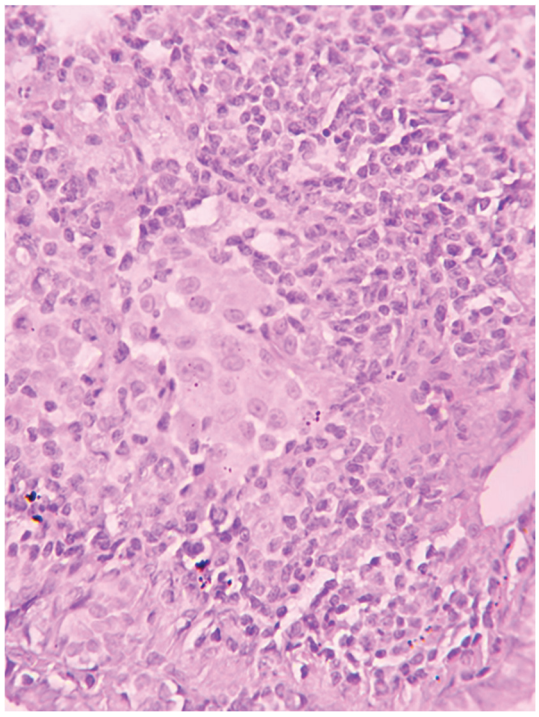

Fig. 4. Formation of the reactive center of the secondary follicle and dilatation of the lumen of exchange and capacitance vessels in the broncho-associated lymphoid tissue of rat small bronchi on week 16 of the experiment. H&E stain. Oc. lens: 10×magnification; ob. lens: 40× magnification.

On week 12 of the experiment, when monosodium glutamate, sodium nitrite and Ponceau 4R were consumed, the average linear size of broncho-associated lymphoid tissue in rat bronchi was 227.66±1.89 μm. This measurement was significantly lower than the values observed on week 8, with a decrease by 22.13 %, as well as by 41.95 % significantly lower than the values in the control group of animals ($p<0.05$). The analysis of the cellular composition revealed a reduction in the number of reticular cells by 1.16 times

and 1.19 %, compared to the values on week 8 of the experiment and the values in the control group, respectively, accounting for 24.39±0.07 FOV($p<0.05$). The average number of plasma cells increased by 2.73 times compared to the previous time period and by 1.63 times compared to the control values, accounting for 294.68±2.51 FOV ($p<0.05$). The number of macrophages decreased significantly by 1.05 times compared to the results of the previous time period, though it was by 1.36 times significantly higher than their average values in the control group. On week 12, it was 164.32±1.50 FOV ($p<0.05$). The average number of lymphocytes significantly decreased by 2.79 times, accounting for 140.52±1.61 FOV, which was by 1.78 times significantly lower than the control values ($p<0.05$) (Table 1).

On week 16 of the experiment, the average linear size of broncho-associated lymphoid tissue was 357.81±7.85 μm. This measurement was by 57.21 % significantly higher compared to the values on week 12 of consuming the complex of food additives. However, it was by 8.76 % significantly lower compared to the values in the control group ($p<0.05$). The average number of reticular cells decreased by 1.09 times compared to the previous time period of the study, which was by 1.30 times lower than the control values, accounting for 22.38±0.17 FOV ($p<0.05$). The average number of plasma cells on week 16 decreased by 1.04 times compared to the values of the previous time period of the experiment, accounting for 284.68±3.44 FOV. However, these values remained significantly higher by 1.58 times compared to the control group ($p<0.05$). The number of macrophages accounted for 144.32±3.71 FOV, which was by 1.14 times significantly lower compared to the values of the previous time period of the experiment, and by 1.20 times significantly higher than the values in the control group ($p<0.05$). The average number of lymphocytes was by 1.09 times significantly lower compared to the values on week 12 and by 1.94 times lower than the control values on week 16 of the experiment, accounting for 128.52±2.36 FOV ($p<0.05$) (Table 1).

Morphometric study of the microcirculatory bed in the broncho-associated lymphoid tissue of rats revealed that the mean values of arteriole lumen diameter were 15.68±0.09 μm, the capillary lumen diameter was 5.23±0.06 μm, and the venule lumen diameter was 31.87±1.83 μm (Table 2).

Table 2

The morphometry of the elements of the microcirculatory bed in the rat broncho-associated lymphoid tissue

Parameters	Arteriole lumen diameter (μm)	Capillary lumen diameter (μm)	Venule lumen diameter (μm)
Control	15.68±0.09	5.23±0.06	31.87±1.83
Week 1	13.67±0.04 *	6.12±0.05 *	39.44±1.31 *
Week 4	9.85±0.04 *,**	6.06±0.07 *	40.08±0.51 *
Week 8	21.03±0.11 *,**	6.84±0.05 *,**	33.07±0.13 **
Week 12	21.56±0.09 *,**	8.20±0.10 *,**	54.25±0.10 *,**
Week 16	24.80±0.42 *,**	7.75±0.12 *,**	50.93±0.21 *,**

Note* - $P<0.05$ compared to the control group; ** - $P<0.05$ compared to the previous time period of the observation.

One-week long consumption of the complex of food additives resulted in a decrease in the average diameter of arterioles in the broncho-associated lymphoid tissue by 12.82 %, accounting for 13.67±0.04 μm. The diameter of capillary lumens significantly increased by 17.02 %, reaching 6.12±0.05 μm, and the diameter of venule lumens was by 23.75 % significantly larger compared to the mean values in the control group of rats, accounting for 39.44±1.31 μm ($p<0.05$) (Table 2).

After 4 weeks of consuming monosodium glutamate, sodium nitrite and Ponceau 4R, the resistance vessels responded with a significant decrease in the average values of the lumen diameter by 27.94 % compared to the previous time period, accounting for 9.85±0.04 μm, and this decrease was also significantly lower than the values in the control group of animals by 37.18 % ($p<0.05$). The average values of the capillary lumen diameter on week 4 were 6.06±0.07 μm, which did not significantly differ from the values of the previous time period of the experiment and were by 15.87 % significantly higher compared to the values of the control group of rats ($p<0.05$). Capacitance vessels responded by a decrease in the average values to 40.08±0.51 μm, which did not significantly differ from the previous values of the study and were by 25.76 % significantly higher than their values in the control group ($p<0.05$) (Table 2).

After 8 weeks of the combined action of food additives, a statistically significant increase in the average values of arteriole lumen diameter by 113.50 %, compared to the results on week 4, was noted, which was also by 34.12 % significantly higher than the values in the control group with the average values of 21.03±0.11 μm

on week 8 ($p<0.05$). Morphometric parameters of capillary lumen diameter significantly increased by 12.87 % and 30.78 % compared to the previous time period of study and the control group, respectively, accounting for 6.84±0.05 μm ($p<0.05$). The venule lumen diameter on week 8 was by 17.49 % significantly lower compared to the previous time period of the study, but these parameters were by 3.77 % significantly higher than the values in the control group of animals, accounting for 33.07±0.13 μm ($p<0.05$) (Table 2).

On week 12 of the consumption of the complex of monosodium glutamate, sodium nitrite and Ponceau 4R the morphometric parameters of arteriole lumen diameter were 21.56±0.09 μm, which was by 2.52 % significantly higher compared to the previous time period of the experiment, and by 37.50 % significantly higher compared to the control group ($p<0.05$). The average values of the capillary lumen diameter were 8.20±0.10 μm, which was by 19.88 % significantly higher compared to their value on week 8 of the experiment and by 56.79 % significantly higher compared to the values in the control group of rats ($p<0.05$). The venule lumen diameter significantly increased by 19.88 % compared to its value on week 8, and it was by 70.22 % significantly higher compared to the values in the control group of animals, accounting for 54.25±0.10 μm on week 12 of the experiment ($p<0.05$) (Table 2).

At the end of the experiment, the impact of the complex of food additives led to a significant increase in the average values of arteriole lumen diameter by 15.03 %, which accounted for 24.80±0.42 μm, and it was by 58.16 % significantly higher compared to the values in the control group ($p<0.05$). The values of the exchange vessels' lumen diameter significantly decreased by 5.49 % compared to the previous term of the experiment, which was by 48.18 % significantly higher compared to the values in the control group of rats, accounting for 7.75±0.12 μm ($p<0.05$). The capacitance vessels responded by a decrease in the lumen diameter with average values of 50.93±0.21 μm, which were by 6.12 % significantly lower compared to the values on week 12 of the experiment, and by 59.81 % significantly higher compared to the average values in the control group of animals ($p<0.05$) (Table 2). Microscopic analysis revealed heterogeneity in the distribution of lymphoid cells. Plasma cells were grouped and occupied a central position in the secondary follicles among reticular cells, while lymphocytes and lymphoblasts were located at the periphery. Capillaries exhibited apparent dilation. Capacitance vessels revealed dilatation of the lumen and signs of congestion (Figure 4).

Thus, the bronchus-associated lymphoid tissue is predominantly located within the walls of small bronchi and bronchioles, formed by lymphocytes and lymphoblasts, which can be distributed diffusely or in aggregations with the formation of lymphoid follicles. In addition to lymphocytes, plasma cells and macrophages are also present, and the stroma is composed of reticular cells. Consumption of the complex of food additives led to changes in morphometric parameters of the linear size during the experiment, characterized by a significant increase in its average values by 73.55 % on week 1 of the experiment, and conversely, a decrease by 41.95 % on week 12, relative to the values in the control group of animals ($p<0.05$). Evidently, these changes reflected alterations in the morphofunctional state of bronchus-associated lymphoid tissue, primarily induced by the differentiation process of lymphoid cells, associated with the formation of reactive centers in the secondary follicles and a general response to the action of the components of the complex of food additives, namely, monosodium glutamate, sodium nitrite and Ponceau 4R. These factors led to the phenomenon of nonspecific inflammation and swelling, as supported by earlier research on the impact of food additives on body tissues directly [5], as well as the effects of other etiological factors [9]. The level of changes in the average number of lymphoid cells had a wave-like nature and was primarily associated with the action of nonspecific factors on lung tissue, leading to cell damage [14] and the development of a nonspecific immune response to the complex of food additives. In the control group of rats, the average number of lymphocytes was 249.53±8.33 FOV, while the number of plasma cells was 180.7±6.79 FOV. At the early stages of the experiment, an increase in the number of plasma cells by 1.78-1.79 times was observed from weeks 1 to 4, accompanied by a decrease in the number of lymphocytes by 2.67 times compared to the control group values. Subsequently, during the experiment, a decrease in the number of plasma cells led to an increase in the number of lymphocytes. This phenomenon reflects the differentiation process of plasma cells in bronchus-associated lymphoid tissue through the transformation of lymphocytes, and the presence of lymphoblasts contributed to the increase in the number of lymphocytes. The previous research on the impact of the complex of food additives has found that their combined action led to damage to the bronchial mucosal epithelium located above the bronchus-associated lymphoid tissue [14], triggering the process of nonspecific inflammation due to an alternative factor, resulting in changes in the morphofunctional composition of bronchus-associated lymphoid tissue, with subsequent formation of the secondary follicles (Figure 4) and changes in cellular composition. The average number of macrophages increases during the experiment, exceeding control values by 1.20 times at the terminal stage of the study due to tissue damage caused by the components of the complex of food additives, which requires subsequent phagocytosis [2]. Macrophages also play a role in the development of nonspecific inflammatory

processes when exposed to the complex of monosodium glutamate, sodium nitrite and Ponceau 4R. Microcirculatory components of bronchus-associated lymphoid tissue showed a tendency to dilatation of vascular lumens in all sections throughout the experiment. At this point, dilatation in arteriole lumens can be attributed to the influence of sodium nitrite on smooth muscle cells in vascular wall [8], and the exchange and capacitance vessels actively participate in the migration of lymphoid cells through vascular walls during the differentiation process in response to the action of an alternative factor. Apparently, the compensatory and adaptive mechanisms do not lead to complete stabilization of the morphometric parameters of bronchus-associated lymphoid tissue components, resulting from the prolonged and continuous action of the components of the complex of food additives.

Conclusion

Consumption of the complex of food additives containing monosodium glutamate, sodium nitrite and Ponceau 4R leads to a state of intense local defense mechanisms. This is characterized by the formation of the secondary lymphoid follicles within the bronchus-associated lymphoid tissue, accompanied by the wave-like changes in the cellular composition. These changes reflect the process of antigen-dependent differentiation of immune cells, as evidenced by an increase in the number of lymphocytes along with a decrease in plasma cells and vice versa. Furthermore, dilatation of the vascular lumens within the microcirculatory system was noted, caused by the migration of immunocompetent cells as a response to the continuous and prolonged action of a nonspecific factor generated by the components of the complex of food additives.

References

1. Asanova EY, Yrhashev ASh, Yshenbaeva SN. Hystolohycheskoe y ymmunohystokhymycheskoe yssledovanye bronkho-assotsyyrovannoi lymfoydnoi tkany u yakov. Nauka, novie tekhnolohyy y ynnovatsyy Kirhizstana. 2021; 1: 39-42. [in Russian].

2. Kaidashev YP. Poliaryzatsyia makrofahov y rehuliatsyia ymmunnoho otveta (obzor lyteraturi y sobstvennikh yssledovanyi). Zhurnal Natsionalnoi akademii medychnykh nauk Ukrainy. 2017; 23(1-2): 9-22. [in Russian].

3. Lapach SN, Chubenko AV, Babych PN. Statystycheskye metodi v medyko-byolohycheskykh yssledovanyiakh s yspolzovanyem Exel. Kyev: Moryon. 2000; 320 s. [in Russian].

4. Lisnianska NV, Novak-Mazepa KhO, Kopanytsia OM, Mialiuk OP, Pak AI. Vyvchennia efektiv poiednanoi dii kharchovykh dobavok. Visnyk medychnykh i biolohichnykh doslidzhen. 2020; 2: 88-90. [in Ukrainian].

5. Bilash VP, Grygorenko AS, Yeroshenko GA, Shevchenko KV, Lysachenko OD, Zviaholska IM et al. The impact of the complex food additives on the glandular apparatus of the rat's duodenal mucosa. World of Medicine and Biology. 2021; 4 (78): 196-202.

6. Egemnazarov B, Schermuly RT, Dahal BK, Elliott GT, Hoglen NC, Surber MW, et al. Nebulization of the acidified sodium nitrite formulation attenuates acute hypoxic pulmonary vasoconstriction. Respir Res. 2010 Jun 21;11(1):81. doi: 10.1186/1465-9921-11-81.

7. Lis K, Bartuzi Z. Natural food color additives and allergies. Alergia Astma Immunol. 2020; 25(2): 95-103.

8. Pankey EA, Badejo AM, Casey DB, Lasker GF, Riehl RA, Murthy SN, et al. Effect of chronic sodium nitrite therapy on monocrotaline-induced pulmonary hypertension. Nitric Oxide. 2012 Jun 30;27(1):1-8. doi: 10.1016/j.niox.2012.02.004.

9. Pronina OM, Koptev MM, Bilash SM, Yeroshenko GA. Response of hemomicrocirculatory bed of internal organs on various external factors exposure based on the morphological research data. World of Medicine and Biology. 2018; 1(63): 153-57.

10. Sweet DG, Carnielli V, Greisen G, Hallman M, Ozek E, Arjan te Pas et al. European Consensus Guidelines on the Management of Respiratory Distress Syndrome - 2019 Update. Neonatology. 2019; 111(4): 432-50.

11. Valluzzi RL, Fierro V, Arasi S, Mennini M, Pecora V, Fiocchi A. Allergy to food additives. Curr Opin Allergy Clin Immunol. 2019;19(3):256-262. DOI: 10.1097/ACI.0000000000000528

12. Wexler P, Editor. Encyclopedia of Toxicology. Reference Work. Third Edition. Academic Press; 2014. 5220 p.

13. Yachmin AI, Kononov BS, Yeroshenko GA, Bilash SM, Bilash VP. Ameasure of the effect of complex food additives on rats'adaptive responses. World of Medicine and Biology. 2020; 1(71): 232-35.

14. Yeroshenko GA, Donets IM, Shevchenko KV, Lysachenko OD, Solod AV, Vatsenko AV et al. Morphometric characteristics of the rat small bronchi in consumption of the complex of food additives. World of Medicine and Biology. 2022; 3(81): 207-214

15. Zanfirescu A, Ungurianu A, Tsatsakis AM, Nițulescu GM, Kouretas D, Veskoukis A, et al. A review of the alleged health hazards of monosodium glutamate. Compr Rev Food Sci Food Saf. 2019; 18(4): 1111-34. doi: 10.1111/1541-4337.12448.

Стаття надійшла 14.08.2022 р.