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Cellular Composition of the Lymphoid Tissue of the Cecal Immune Formations in Ducks

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Abstract. Observing the quantitative and qualitative composition of immunocompetent cell populations of the lymphoid tissue of the immunogenic organs allows to determine the immune status of the organism in a certain age period. The object of research is determining the cellular composition of the lymphoid tissue of the cecal Peyer's patches and cecal (apical) diverticula in ducks in age-concerned aspect. Material samples for research were selected from broiler ducks of the Blagovarsky cross. Cytological tests were performed on imprint specimens. Immunoblasts, lymphocytes, proplasmocytes, and plasmocytes, monocytes, and macrophages are distinguished among the cells of the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula. The content of these cells is not the same. Population of lymphocytes in imprint specimens is the biggest. It consists of subpopulations of small, medium, and large lymphocytes, the ratio is uneven. The largest is a subpopulation of small lymphocytes, and the smallest is a subpopulation of large ones. The total content of lymphocyte in cecal Peyer's patches and cecal diverticula decreases with age of the subject ducks. The content of small and medium-sized lymphocytes in the cecal diverticula and small lymphocytes in the cecal Peyer's patches as well decreases. Simultaneously, the content of large lymphocytes in the cecal diverticula, large and medium lymphocytes in the cecal Peyer's patches increases. The immunoblasts content in the lymphoid tissue of the studied immune formations decreases with age of ducks, while the quantity of macrophages and monocytes conversely increases. Proplasmocytes and plasmocytes are detected in the lymphoid tissue of cecal Peyer's patches and cecal diverticula from the age of 10 days in ducks. Their content increases significantly with the poultry age. Reticular cells observation is complicated due to their location under a dense layer of lymphoid cells. Fibroblasts, M-cells, erythrocytes, and granulocytes in imprint specimens are detected in trace amounts. The established changes in the cellular composition of the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula in ducks in the age-related aspect confirm the occurring immune reactions within them. Consideration of these changes will improve the effectiveness of anti-epizootic measures

Keywords: Peyer's patches, cecal diverticula, lymphocytes, plasmocytes, macrophages

Introduction

The intensive development of poultry farming in Ukraine and the rapid growth of production volumes require significant attention from morphologists in conducting the necessary comprehensive studies of the morphogenesis of all body systems, especially the poultry digestive system, to prevent diseases, effectively treat them, and obtain high-quality food products [1].

The main function of immunocompetent organs and structures of the body is the formation of immunity. They

can produce cellular and humoral factors that free the body of foreign proteins (antigens). Therefore, the morphofunctional state of the immunogenesis organs substantially affects the viability and productivity of poultry. Improvement of poultry breeding and exploitation technologies in order to ensure their viability and Table increase in productivity is possible only in the presence of deepened knowledge about the peculiarities of the morphofunctional formation of the immunogenous organs in the postnatal

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period of ontogenesis, including their cellular composition. Study on quantitative and qualitative characteristics of immunocompetent cells populations of lymphoid tissue of the immune formations in mammals and birds digestive tract make it possible to assess the immune status of the organism in a certain age period and, accordingly, to form a diet and organize anti-epizootic measures.

The immune system includes the hematopoietic and lymphopoietic organs, which also include clusters of different lymphocyte populations are localized in all tissues of the organism. The birds' immune system ensures homeostasis of their organism by destroying genetically foreign agents. It produces substances and cells that neutralize antigens through immune recognition responses. These processes are characteristic of peripheral hematopoietic and lymphopoietic organs, including immune formations of the digestive system [2; 3].

In birds, lymphoid (immune) formations of the digestive canal is associated with mucosa, consist of separately located lymphoid nodules, their clusters (Peyer's patches), Meckel's diverticulum and cecal (apical) diverticula. Among the peripheral hematopoietic and lymphopoietic organs, they are the first to encounter antigens that enter the bird's organism through feed and water, and are constantly exposed to them [4]. Due to the significant antigenic load, the lymphoid tissue of the digestive canal is extremely well developed and makes up about 70% of the lymphoid tissue of all immunocompetent structures of the animal organism. In addition, it constantly differentiates harmless antigens present in feed or commensal bacteria from pathogenic bacteria. As a result, the lymphocytes population of immune formations of the digestive organs is substantially larger than in all secondary lymphoid organs combined [5].

Among the organs of the bird's digestive canal, immune formations are extremely well developed in the ceca, which is explained by the peculiarities of their purpose, namely: they provide the absorption of feed nutrients and water, as well as conversion of uric acid and the production of volatile fatty acids. The ceca are inhabited by microbiota involved in the utilization of feed with significant fibre content. They are peculiar antigens that affect the cecal mucosa, inducing the formation of immune formations in it [6-8].

Immune formations of the birds ceca are represented by cecal diverticula, cecal tonsils (one in each intestine), and numerous Peyer's patches. The latter are mainly localized in the body and apex of the intestines. As mentioned above, these immune formations, which are characterised by lymphocyte-epithelial symbiosis, belong to the peripheral organs of immunogenesis. The transformation of lymphocytes into effector cells occurs under the action of antigens within them. Effector cells, together with the secreted substances, determine the formation of cellular and humoral immunity [9-11]. It is the optimal balance of immunocompetent cells from pluripotent stem cells to effector cells (lymphocytes, plasmocytes, and macrophages) that ensures the formation of immunity. These cells are constantly in the processes of proliferation, differentiation, migration, cooperation, and apoptosis [12; 13].

In ducks, immune formations are located at the base of the ceca and are represented by numerous Peyer's patches and cecal (apical) diverticula. The literature contains

information on the morphogenesis of the mentioned immune formations [14-16], but data on the cellular composition of their lymphoid tissue is insufficient.

The purpose of the study was to identify the dynamics of the quantitative and qualitative composition of immunocompetent cells populations of the lymphoid tissue of Peyer's patches and the cecal diverticula in ducks with age.

Materials and Methods

Cytological studies were performed in the scientific laboratory of immunomorphology of the Department of Anatomy, Histology and Pathomorphology of Animals named after academician Volodymyr Kasyanenko of National University of Life and Environmental Sciences of Ukraine during 2011-2021.

All manipulations and euthanasia of subject poultry were performed by acute exsanguination under ether anesthesia, for which chloroethyl was used in the form of inhalations. All procedures were conducted in accordance with the "General Ethical Principles of Animal Experiments" (Ukraine, 2001) [17], which is consistent with the Law of Ukraine "On the Protection of Animals from Cruelty" of 02/21/2006 No. 3447-IV [18] and the provisions of the "European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes" [19].

Material for the study was selected from 80 broiler ducks of the Blagovarsky cross of 1, 5, 10, 15, 20, 25, 30, 60, 90, 120, 150, 180, 210, 240, 330, and 420 days old (5 ducks of each age).

Cytological studies were performed on imprint specimens. A section of the immune formation (Peyer's patch, cecal diverticulum) was cut with a sharp blade to prepare specimen samples. Further, using filter paper, excess moisture was removed from it and applied to a defatted slide at the appropriate incision site. The obtained imprint specimens were air-dried. For cytological studies, they were stained according to Wright with commercial dyes Leucodif 200 (Erba Lachema, Czech Republic) and according to Papenheim with Hemocolor dyes (Merck, Germany) [20]. Stained imprint samples were examined using microscope Olympus (Japan) ($\times 1000$). Cells were differentiated and their number determined. Cells were counted using microscope in 5 fields of view in one specimen. 50-70 cells were counted in one observed area [21]. The specimens were examined using light microscopes MBS-2, "Biolam" and "Olympus".

The results of the studies were entered into the protocols, and their digital indicators were subjected to statistical processing using a personal computer using the StatSoft Statistica 13.1 (2015) program, considering the specific features of statistical methods in biomedical studies [22].

Results and Discussion

As a result of the examination of imprint-samples of cecal Peyer's patches and cecal diverticula of ducks in the age-related aspect, populations of cells were identified in their lymphoid tissue: lymphoid lineage – immunoblasts, lymphocytes, proplasmocytes, and plasmocytes; blood cells – erythrocytes, granulocytes, monocytes, including macrophages, as well as tunica mucosa tissues – reticular, fibroblasts, epithelial, and M-cells (Figs. 1, 2).

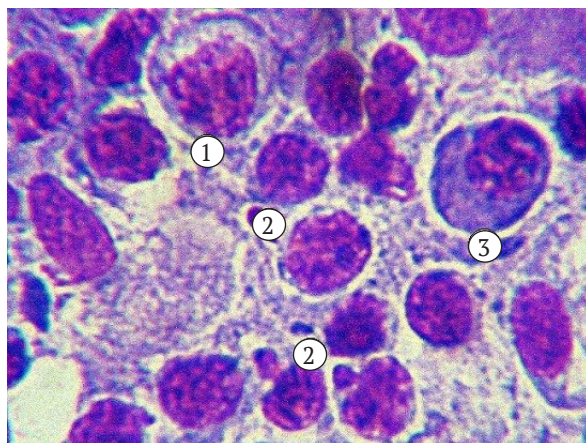


Figure 1. Cells of the cecal Peyer's patches in 240 day-old duck

Note: 1 – immunoblast; 2 – lymphocytes; 3 – plasmocyte. Imprint specimen. Wright staining, ×1000

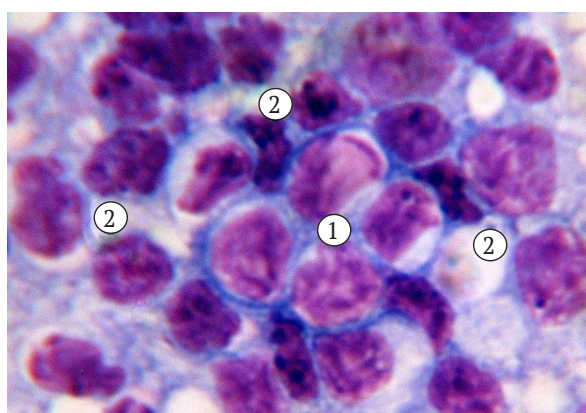


Figure 2. Cells of the cecal diverticula in 90 day-old duck

Note: 1 – immunoblasts; 2 – lymphocytes. Imprint specimen. Wright staining, ×1000

These cells in the immune formations of the digestive canal of birds were also identified by other researchers [23-25]. According to the results of the conducted studies, it was discovered that the content of populations of these cells is variable. Determining the content of reticular cells is complicated by their placement under a dense layer of lymphoid cells. Fibroblasts, M-cells, erythrocytes, and granulocytes in imprint specimens are detected in trace amounts.

Among the cells in the cecal Peyer's patches and the cecal diverticula in ducks, the lymphocytes are prevailing (Table 1, 2). This outcome corresponds consistent with data from other researchers who have studied the cellular contents of the esophageal tonsil [23], Peyer's patches [24] in

chickens, and Peyer's patches in ducks [25]. Their structure is similar to that in mammals and other bird species. Lymphocytes on imprint specimens are predominantly rounded. Their nuclei are very large and occupy almost the entire volume of the cell and are basophilic, have different shapes and uneven contours (see Figs. 1, 2). The shape of the nuclei can vary from round to slightly elongate. Heterochromatin is attached in substantial amounts to the inner membrane of the nuclear envelope, and also in the form of grains and lumps is freely located throughout the nucleoplasm. Due to the high content of heterochromatin, it is difficult to differentiate the nucleolus in the nucleus. The cytoplasm of lymphocytes is poorly distinguished. It is coloured slightly basophilic and surrounds the nucleolus in the form of a thin blue stripe.

Table 1. The cell content in cecal Peyer's patches in duck, %, M ± m, n = 5

Age, days	Immunoblasts	Lymphocytes	Proplasmocytes and plasmocytes	Macrophages and monocytes
1	33.57 ± 0.56	64.41 ± 0.53	–	2.02 ± 0.16
5	33.02 ± 0.39	64.91 ± 0.41	–	2.07 ± 0.09
10	32.17 ± 0.39	64.34 ± 0.28	0.87 ± 0.10	2.61 ± 0.08
15	31.79 ± 0.57	61.53 ± 0.27	3.34 ± 0.28*	3.34 ± 0.25
20	31.12 ± 0.54	60.58 ± 0.16	4.15 ± 0.4	4.14 ± 0.24
25	30.06 ± 0.35	59.66 ± 0.09	5.85 ± 0.22	4.43 ± 0.23
30	29.42 ± 0.53	59.49 ± 0.44	6.71 ± 0.17	4.37 ± 0.13

Table 1, Continued

Age, days	Immunoblasts	Lymphocytes	Proplasmocytes and plasmocytes	Macrophages and monocytes
60	29.71 ± 1.29	57.88 ± 1.34	7.69 ± 0.51	4.72 ± 0.41
90	28.34 ± 0.34	59.08 ± 0.39	7.10 ± 0.16	5.47 ± 0.14
120	29.12 ± 0.29	59.89 ± 0.41	6.88 ± 0.44	4.11 ± 0.33
150	29.27 ± 0.36	59.69 ± 0.41	6.29 ± 0.44	4.74 ± 0.04
180	28.91 ± 0.34	59.53 ± 0.37	6.42 ± 0.19	5.14 ± 0.12
210	26.94 ± 0.11	58.92 ± 0.23	8.18 ± 0.13*	5.96 ± 0.08
240	26.25 ± 0.07	59.39 ± 0.13	8.44 ± 0.17	5.92 ± 0.14
330	25.95 ± 0.19	59.21 ± 0.25	9.06 ± 0.32	5.78 ± 0.07
420	25.14 ± 0.15	59.25 ± 0.28	9.15 ± 0.46	6.46 ± 0.26

Note: * P < 0.05, compared to the indicator in the previous age group

Table 2. The cell content in the cecal diverticula in duck, %, M ± m, n = 5

Age, days	Immunoblasts	Lymphocytes	Proplasmocytes and plasmocytes	Macrophages and monocytes
1	28.84 ± 0.23	69.38 ± 0.26	–	1.78 ± 0.15
5	32.25 ± 0.30*	66.03 ± 0.39	–	1.72 ± 0.15
10	33.66 ± 0.47	63.76 ± 0.55	0.39 ± 0.11	2.18 ± 0.20
15	30.38 ± 0.46	62.97 ± 0.19	3.35 ± 0.29*	3.30 ± 0.30
20	30.41 ± 0.43	61.18 ± 0.21	3.86 ± 0.36	4.56 ± 0.25
25	29.86 ± 0.36	59.83 ± 0.17	5.80 ± 0.34	4.51 ± 0.20
30	29.09 ± 0.48	59.09 ± 0.42	7.03 ± 0.25	4.77 ± 0.16
60	30.01 ± 1.19	56.96 ± 1.09	7.61 ± 0.39	5.42 ± 0.50
90	27.48 ± 0.40	57.80 ± 0.45	8.31 ± 0.19	6.40 ± 0.16
120	24.63 ± 1.87	62.66 ± 1.65	7.58 ± 0.33	5.12 ± 0.47
150	27.13 ± 0.44	60.59 ± 0.72	7.04 ± 0.54	5.25 ± 0.06
180	28.07 ± 0.47	58.46 ± 0.55	7.49 ± 0.24	5.99 ± 0.14
210	25.79 ± 0.12	57.81 ± 0.23	9.49 ± 0.14*	6.91 ± 0.09
240	25.08 ± 0.09	58.21 ± 0.14	9.82 ± 0.20	6.88 ± 0.16
330	24.69 ± 0.22	58.18 ± 0.24	10.45 ± 0.35	6.68 ± 0.08

Note: * P < 0.05, compared to the indicator in the previous age group

The content of lymphocytes in the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula decreases with the increasing of the ducks age (see Table 1, 2). This is due to their differentiation into effector cells. Changes in the content of lymphocytes in the lymphoid tissue of the esophageal tonsil in chickens were also recorded by N.V. Dyshliuk [23]. According to the data, up to the 60-day age of chickens, there is an increase in this indicator, and in older birds – a decrease. In cecal Peyer's patches from 1 day to 420 days of the ducks age, the content of lymphocytes decreases by 1.09 times. In the cecal diverticula, this indicator decreases more rapidly (by 1.19 times) in a shorter period – from 1-day to 330-day age of ducks (the age when the cecal diverticula are detected for the last time). The decrease in the number of lymphocytes occurs unevenly and in waves. By the age of 60 days, the content of these cells in the cecal Peyer's patches decreases by 1.11 times, and in the cecal diverticula – by 1.22 times. Moreover, in the first five days of the duck's life, this indicator increases (by 1.01 times) in Peyer's patches of ducks,

and the most intense (by 1.05 times) decrease is recorded in the cecal diverticula. The content of lymphocytes in the cecal Peyer's patches decreases most intensively (by 1.05 times) from 10 to 15 days. Over the period from 60 to 120 days, the content of lymphocytes in the cecal immune formations increases. Thus, in the cecal Peyer's patches, this indicator increases by 1.04 times (from 60 to 90 days – by 1.02 times, from 90 to 120 days – by 1.01 times). In cecal diverticula, during this period, the increase in the content of lymphocytes occurs more intensively – by 1.10 times (from 60 to 90 days – by 1.01 times, from 90 to 120 days – by 1.08 times). In older ducks, this indicator changes in waves, decreasing in the cecal Peyer's patches by 1.01 times to 420-day age, and in the cecal diverticula – by 1.08 times to 330-day age.

In the cecal Peyer's patches and the cecal diverticula, we found small (d up to 7 µm), medium (d 7-10 µm), and large (d more than 10 µm) lymphocyte among the total content of lymphocytes. The content of populations of these cells is not the same (see Table 3, 4).

Table 3. The content of different groups of lymphocytes in the cecal Peyer's patches in ducks, %, M ± m, n = 5

Age, days	Lymphocytes		
	Small	Medium	Large
1	56.44 ± 0.45	35.93 ± 0.71	7.63 ± 0.67
5	56.09 ± 0.93	35.83 ± 0.72	8.08 ± 0.71
10	55.38 ± 0.47	36.09 ± 0.66	8.52 ± 0.4
15	54.64 ± 0.36	35.93 ± 0.36	9.42 ± 0.57
20	54.86 ± 0.29	35.94 ± 0.49	9.20 ± 0.54
25	54.93 ± 0.94	36.23 ± 0.47	8.84 ± 0.64
30	53.83 ± 0.47	37.93 ± 0.76	8.24 ± 0.47
60	53.94 ± 0.22	35.92 ± 1.72	10.15 ± 1.23
90	52.43 ± 0.72	38.26 ± 0.1	9.31 ± 0.67
120	51.53 ± 0.27	38.06 ± 0.28	10.41 ± 0.38
150	52.46 ± 0.92	36.47 ± 0.81	11.07 ± 0.35
180	52.99 ± 0.33	36.19 ± 0.35	10.81 ± 0.35
210	53.28 ± 0.36	35.60 ± 0.39	11.12 ± 0.23
240	53.67 ± 0.13	35.25 ± 0.23	11.08 ± 0.17
330	53.12 ± 0.15	35.56 ± 0.18	11.32 ± 0.14
420	51.45 ± 0.42	36.69 ± 0.62	11.86 ± 0.54

Table 4. The content of different groups of lymphocytes in the cecal diverticula in ducks, %, M ± m, n = 5

Age, days	Lymphocytes		
	Small	Medium	Large
1	58.39 ± 0.47	35.88 ± 0.89	5.74 ± 0.62
5	58.56 ± 0.99	35.18 ± 0.88	6.26 ± 0.59
10	58.25 ± 0.65	34.92 ± 0.84	6.83 ± 0.36
15	57.68 ± 0.47	35.43 ± 0.44	6.89 ± 0.56
20	57.72 ± 0.49	34.33 ± 0.60	7.94 ± 0.63
25	58.65 ± 0.85	34.43 ± 0.40	6.92 ± 0.61
30	57.41 ± 0.38	35.13 ± 0.65	7.46 ± 0.50
60	56.42 ± 0.47	35.57 ± 1.29	8.00 ± 0.91
90	56.53 ± 0.73	36.58 ± 0.41	7.89 ± 0.81
120	55.27 ± 0.38	35.42 ± 0.29	9.31 ± 0.45
150	54.51 ± 1.21	35.21 ± 1.02	10.28 ± 0.32
180	57.73 ± 0.41	32.66 ± 0.30	9.61 ± 0.40
210	57.35 ± 0.53	32.60 ± 0.44	10.04 ± 0.11
240	58.12 ± 0.15	31.23 ± 0.17	10.66 ± 0.24
330	56.41 ± 0.19	33.32 ± 0.13*	10.27 ± 0.15

Note: * P < 0.05, compared to the indicator in the previous age group

In the studied immune formations in ducks of all age groups, small lymphocytes detected most of all. Their nucleus is very large, contains a lot of heterochromatin, and is intensely coloured. The cytoplasm volume of small lymphocytes is insubstantial. It has the appearance of a narrow blue stripe, which in the form of a sickle does not completely surround the nucleus. The content of small lymphocytes in the cecal Peyer's patches is less than in the cecal diverticula (see Table 3, 4). This indicator decreases unevenly by almost 1.10 times from 1-day to 420-day of

age. The most intense decrease in this indicator is observed from 330 to 420 days (by 1.03 times) (see Table 3). The content of small lymphocytes in the cecal diverticula decreases unevenly by almost 1.04 times from 1-day to 330-day of age. Simultaneously, the minimum value of this indicator is recorded in 150-day-old poultry (54.51 ± 1.21%), and the maximum value is recorded in 25-day-old poultry (58.65 ± 0.85%) (see Table 4).

The results obtained are consistent with the data of K.O. Medvid [26] on the cellular composition of the cecal

tonsil in chickens. According to this information, the cecal tonsil in chickens aged from 1 to 90 days is mainly represented by diffuse lymphoid tissue, which is formed mainly by small lymphocytes, among which plasmoblasts and macrophages are found in small amounts.

Medium lymphocytes have a larger volume of the nucleus and cytoplasm. The heterochromatin saturation of the nuclei is lower, as a result of which they are less intensely stained (see Fig. 1). The content of medium lymphocytes in the lymphoid tissue of the cecal Peyer's patches and cecal diverticula is less than that of small lymphocytes (see Table 3, 4). In 1-day-old ducks in the immune formations, this indicator is almost the same (see Table 3, 4). In the cecal Peyer's patches and the cecal diverticula, the content of medium lymphocytes from 1-day to 90-day of age changes unevenly in waves, generally increasing almost by 1.07 and 1.02 times, respectively. In older poultry, up to 240 days of age, the content of medium lymphocytes in both immune formations decreases unevenly, reaching minimal values. From 90 to 240 days, the content of medium lymphocytes in the cecal Peyer's patches decreases by almost 1.09 times, and in the cecal diverticula – by 1.17 times. The most intense decrease in this indicator in the cecal Peyer's patches is recorded from 120 to 150 days (by over 1.04 times), in the cecal diverticula – from 150 to 180 days (by 1.08 times). In older poultry, the content of medium lymphocytes in the cecal Peyer's patches increases by 1.04 times, and from 330 to 420 days over by 1.03 times (see Table 3). In cecal diverticula from 240 to 330 days, the most intense increase (by 1.07 times) of this indicator is noted (see Table 4).

The content of large lymphocytes in the lymphoid tissue of the immune formations is the smallest (see Table 3, 4). Among lymphocytes, these cells have the largest volume of the nucleus and cytoplasm. The nucleus contains small lumps of heterochromatin and is less intensely stained. The cytoplasm appears as a thin, slightly basophilic streak. In the cecal Peyer's patches in ducks, the content of large lymphocytes is higher than in the cecal diverticula (see Table 3, 4). In the immune formations, this indicator increases unevenly. Thus, in the cecal Peyer's patches from 1-day to 420-day of age in ducks, the content of large lymphocytes increases by over 1.55 times (see Table 3), and in the cecal diverticula from 1-day to 330-day of age in ducks – by 1.79 times (see Table 4). The most intense growth of this indicator in Peyer's patches is observed in ducks aged from 30 to 60 days (by 1.23 times), and in the cecal diverticula – from 90 to 120 days (by 1.18 times) (see Table 3, 4).

Immunoblasts are cells of the fifth class of lymphopoiesis [27]. They are larger than lymphocytes. The shape of immunoblasts varies from round to slightly elongate. The cytoplasm of these cells has a much larger volume compared to lymphocytes (see Figs. 1; 2). It surrounds the nucleus in the form of a slightly basophilic streak of unequal thickness. The nucleus is round. Most immunoblasts contain two nucleoli. There is less heterochromatin in the nucleus than in lymphocytes. It is evenly sprayed in the nucleoplasm, and part of it is fixed near the inner membrane of the nucleolemma. The content of immunoblasts in the immune formations in ducks of all age groups is less than that of lymphocytes (see Table 1, 2). In most age groups of ducks, this indicator is higher in the cecal Peyer's patches than in the cecal diverticula. In general, the content

of immunoblasts in the cecal Peyer's patches in ducks unevenly decreases from 1-day to 420-day of age by over 1.34 times (see Table 1), and in the cecal diverticula – by 1.17 times (see Table 2). This indicator decreases most intensively in Peyer's patches in ducks aged from 180 to 210 days (by 1.09 times). In the cecal diverticula in ducks from 1 to 10 days, the content of immunoblasts increases almost by 1.17 times, reaching its maximum value (see Table 2). A more pronounced increase in this indicator (by 1.12 times) is recorded from the first to 5 days. In older poultry, the content of immunoblasts decreases unevenly by over 1.36 times by the age of 330 days. With a maximum intensity (by 1.12 times), this process occurs in ducks aged from 90 to 120 days (see Table 2).

In the intestines of poultry, the content of antigens of various origins increases with age, in the neutralisation of which antibodies play a decisive role [28-30]. With the help of antigen-presenting cells, such as M cells, dendritic cells and macrophages, antigens from the intestinal lumen enter the lymphoid tissue of intestinal immune formations [25; 31; 32]. As a result of the action of the antigen, an increase in the number of plasma cells capable of producing antibodies is observed [23; 33; 34], which is confirmed by the results of our study.

Plasmocytes and proplasmocytes are found in small amounts in imprint specimens. Plasmocytes are effector cells of B-lymphocytes, proplasmocytes, are precursors of plasmocytes. Proplasmocytes are mostly small in size. Their shape varies from slightly elongated to irregular oval. The nucleus of proplasmocytes has uneven contours and shape. It is intensively coloured due to the high content of heterochromatin. The latter is partially sprayed in the nucleoplasm, but most of it is fixed to the inner membrane of the nucleolemma in the form of triangles and trapezoids. One or two nucleoli are found in the nucleus. The cytoplasm is stained basophilic and has a larger volume than that of lymphocytes. Plasmocytes are also small cells with an eccentrically arranged nucleus. They are characterised by a rounded or oval shape (see Fig. 1). There are many lumps of highly condensed heterochromatin in the nucleus, which is fixed to the inner membrane of the nucleolemma mainly in the form of triangles, forming a characteristic pattern of a wheel or watch face. The nucleolus cannot be detected in the nucleus. In the cytoplasm near the nucleus, a zone of brightening is found – this is the place of the Golgi complex localisation. The volume of the cytoplasm exceeds the volume of the nucleus. Proplasmocytes and plasmocytes in the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula in ducks are detected in small amounts from the age of 10 days (see Table 1, 2). The content of these cells in the cecal Peyer's patches increases over tenfold with the age (by 10.52 times), in 420-day-old birds is $9.15 \pm 0.46\%$, in the cecal diverticula – by 26.8 times, and in 330-day-old ducks, it is $10.45 \pm 0.35\%$. The maximum apparent increase in this indicator is recorded in ducks aged from 10 to 15 days: in the cecal Peyer's patches – by 3.84 times and in the cecal diverticula – by 8.59 times. Moreover, it is during this period that the cecal Peyer's patches show the most intense (by 1.05 times) increase in the content of lymphocytes.

Monocytes are known to be progenitors of macrophages. These are large cells that have a horseshoe-shaped or bean-shaped nucleus. Heterochromatin in the nucleus

condenses into lumps that are evenly distributed throughout the nucleoplasm. All common-functions organelles are well developed in the cytoplasm. Macrophages are big in size, have a round or elongated oval shape with uneven edges. The macrophage nucleus is small comparing to the cell volume. Heterochromatin is located in large amounts on the inner membrane of the nucleolemma and in the nucleoplasm. The cytoplasm of macrophages has a substantial volume and forms protrusions (cytopodia) of various sizes and shapes. It contains many large round shape lysosomes, many phagosomes of different sizes and shapes, fewer mitochondria, tubules of the endoplasmic reticulum, and elements of the Golgi complex. The content of monocytes and macrophages in the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula in ducks of almost all studied age groups is the lowest (see Table 1, 2). This indicator in the cecal Peyer's patches increases unevenly from 1-day to 420-day of age by 3.20 times. A rapid increase in the content of monocytes and macrophages in the lymphoid tissue of the cecal Peyer's patches is recorded in the period from 5 to 20 days. Thus, from 5 to 10 days it increases by 1.26 times, from 10 to 15 days – by 1.28 times and from 15 to 20 days – by 1.20 times. In the cecal diverticula lymphoid tissue in ducks, this indicator increases unevenly from 1-day to 330-day age by 3.75 times. The maximum increase in monocytes and macrophages' content in the cecal diverticula's lymphoid tissue is recorded in ducks aged from 10 to 15 days (by 1.51 times).

Conclusions

Immunoblasts, lymphocytes, proplasmocytes, plasmocytes, monocytes, and macrophages are found among the cells of the lymphoid tissue of the cecal Peyer's patches and

the cecal diverticula of all studied age groups in ducks. The quantitative characteristics of these cells populations are not the same. The most numerous population of the cecal Peyer's patches and the cecal diverticula in the imprint specimens are the lymphocytes. Their content decreases by 1.09 and 1.19 times, respectively, with the age of ducks. Among the lymphocytes, small, medium, and large forms are distinguished. Most of all, small lymphocytes are detected, and least of all – large ones. With the age of ducks, the content of small lymphocytes in the cecal Peyer's patches and the cecal diverticula decreases by 1.04 and 1.10 times, respectively, and medium lymphocytes in the cecal diverticula – by 1.08 times. The content of large lymphocytes increases in the cecal diverticula by 1.79 times, in the cecal Peyer's patches – by 1.55 times, and medium lymphocytes – by 1.02 times.

The content of immunoblasts in the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula decreases by 1.34 and 1.17 times with the age in ducks, respectively.

Proplasmocytes and plasmocytes in the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula are detected from the age of 10 days of ducks. Their content in the immune formations increases substantially with the age of the bird – by 10.52 and 26.80 times, respectively.

The content of macrophages and monocytes in the lymphoid tissue of the cecal Peyer's patches and the cecal diverticula increases by 3.20 and 3.75 times with the age in ducks, respectively.

In the future, it is planned to examine certain immunohistochemical characteristics of lymphocytes subpopulations and some cells of lymphoid tissue in the intestinal immune formations of Blagovarsky cross ducks.

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Клітинний склад лімфоїдної тканини імунних утворень сліпих кишок качок

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Анотація. Встановлення закономірностей щодо змін кількісного і якісного складу популяцій імунокомпетентних клітин лімфоїдної тканини органів імуногенезу дозволяє визначати імунний статус організму в певний віковий період. Метою дослідження було вивчити клітинний склад лімфоїдної тканини плямок Пейера сліпих кишок і сліпокишкових (апикальних) дивертикулів качок у віковому аспекті. Матеріал для дослідження відібрали від

бройлерних качок Благоварського кросу. Цитологічні дослідження проводили на препаратах-відбитках. Серед клітин лімфоїдної тканини плямок Пейера сліпих кишок та сліпокишкових дивертикулів виявляються імунобласти, лімфоцити, проплазмоцити і плазмоцити, моноцити і макрофаги. Вміст цих клітин неоднаковий. Популяція лімфоцитів у препаратах-відбитках є найбільшою. Вона складається із субпопуляцій малих, середніх і великих лімфоцитів, які є нерівнозначними. Найбільшою є субпопуляція малих лімфоцитів, а найменшою – великих. Загальний вміст лімфоцитів у плямках Пейера сліпих кишок та сліпокишкових дивертикулах зменшується з віком качок. Водночас уміст малих і середніх лімфоцитів в сліпокишкових дивертикулах та малих лімфоцитів у плямках Пейера сліпих кишок зменшується. Вміст великих лімфоцитів у сліпокишкових дивертикулах та великих і середніх лімфоцитів у плямках Пейера сліпих кишок збільшується. Кількість імунобластів у лімфоїдній тканині досліджених імунних утворень з віком качок зменшується, а макрофагів і моноцитів – зростає. Проплазмоцити і плазмоцити у лімфоїдній тканині плямок Пейера сліпих кишок та сліпокишкових дивертикулів виявляються з 10-добового віку качок. Уміст їх із віком птиці значно збільшується. Ретикулярні клітини розташовані під щільним шаром лімфоїдних клітин, тому їх визначення ускладнюється. Фібробласти, М-клітини, еритроцити і гранулоцити у препаратах-відбитках виявляються в слідових кількостях. Встановлені зміни клітинного складу лімфоїдної тканини плямок Пейера сліпих кишок і сліпокишкових дивертикулів качок у віковому аспекті підтверджують перебіг в них імунних реакцій. Врахування цих змін дозволить підвищити ефективність проведення протиєпізотичних заходів

Ключові слова: плямки Пейера, сліпокишкові дивертикули, лімфоцити, плазмоцити, макрофаги