Influence of *Spirulina platensis* biomass in compound feed composition on the dynamics of morphological parameters of broiler chickens' blood

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**Abstract.** The article presents data on the dynamics of morphological parameters of broiler chickens' blood when spirulina biomass is introduced into the diet in the amount of 5 g/kg of compound feed. The use of spirulina biomass as part of the compound feed led to an increase in the number of erythrocytes, hematocrit, leukocytes, hemoglobin concentration in the birds' blood of the experimental group during the experiment. The number and % content of agranulocytes, granulocytes, platelets, the average volume of erythrocytes and the average concentration of corpuscular hemoglobin in birds' erythrocytes of the experimental group is characterized by uneven changes. Hematological studies revealed that in the birds' blood of the experimental group by 42 days age, there was an increase in the number of neutrophils, basophils, platelets and an increase in the proportion of % of the content of neutrophils and basophils, and the number of lymphocytes, eosinophils and the proportion of their % content decreased.

**1 Introduction**

Complete feeding of broiler chickens is an urgent problem of poultry farming. To increase the productivity of poultry, diets are used that include spirulina - blue-green microalgae (cyanobacteria) in various forms [6, 9, 12, 15-17, 19-20, 20-21, 37].

The study of the dynamics of the morphological parameters of birds’ blood allows you to obtain information about the functional state of both individual systems and the body as a whole, which is an important component in a comprehensive, comparative assessment of metabolism and is of diagnostic value for an objective assessment of their physiological state [1-3, 4 -5, 10-11, 13-14, 18, 22-24].

The purpose of the study is to study the effect of spirulina (*Spirulina platensis*) biomass in the feed composition on the dynamics of morphological blood parameters in broiler chickens.

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2 Material and methods

An experiment to study the effect of spirulina biomass on the dynamics of morphological blood parameters in broiler chickens was carried out in the vivarium of the Faculty of Veterinary Medicine. The object of the study was broiler chickens aged from 14 to 42 days, divided according to the principle of analogues into experimental and control groups of 45 heads in each. The experimental group of broiler chickens received spirulina biomass at a dose of 5 g per 1 kg of compound feed with the main diet throughout the experiment, from the daily to slaughter age (42 days), and the control group received only the main diet. Feeding of the birds in the experimental and control groups was carried out with compound feed for broiler chickens in accordance with the recommended feeding norms and guidelines for this cross, depending on age, compound feed was used prestart 0-14 days, growth from 15-34 days and finish - from 35 days to the end fattening. To study the morphological parameters of blood, slaughter of broiler chickens was carried out at the age of 14, 21, 28, 35 and 42 days in the amount of 3-4 heads from each group. Blood sampling from birds was carried out by dissecting the palatine blood vessels with eye scissors into test tubes with heparin. Blood parameters of birds were studied on a DF50 Vet hematological analyzer. Statistical data processing was carried out in the Microsoft Excel program, the reliability of the data was carried out using the Student's criterion [7].

3 Results and discussion

The number of erythrocytes per unit volume of broiler chickens' blood in the experimental group was higher than that in the control group at the age of 14 days by 10.2%, at the age of 21 and 28 days by an average of 9.6%, and by 35 days. This difference was greatest for age (13%). At the age of 42 days the value of the indicator in the blood of the birds of the experimental group exceeded the control one by 1.5% (Table 1).

During the experimental study, the hemoglobin content in the birds of the experimental group was higher than that of the control group analogues at the age of 14 day. – by 3.4%, at the age of 21, 28 and 35 days by an average of 6.9%. An increase in the hemoglobin content in the blood of broiler chickens is associated with an increase in their number or size of erythrocytes [23].

The number of erythrocytes and the concentration of hemoglobin in broiler chickens' blood of the experimental group was higher compared to the control group, due to the presence of phycocyanin in the biomass of spirulina, which promotes the release of the hormone erythropoietin, as well as iron, copper and zinc, which activate erythropoiesis [2-4, 6, 8, 14, 17, 26-29, 30-33, 36, 38].

At the age of 14, 21, 28 and 35 days. an increase in hematocrit by 1.98, 0.38, 1.33 and 2.73% was found in the experimental group of birds in relation to the control, respectively. This result is confirmed by Mariey et al. (2012), who showed a slight increase in hematocrit in birds by 2.3 and 3.0%, when spirulina was introduced into the diet at a dose of 0.2 and 0.3 g per 1 kg of compound feed, compared with the control group.

In the birds’ blood of the experimental group by 42 days age, there was a decrease in hematocrit by 0.66% compared with the control.

In the birds’ experimental group aged 14 and 35 days the average erythrocyte volume increased by 1.58-1.73% regarding control. The average volume of erythrocytes in the birds’ experimental group was less than in the control group at the age of 21, 28 and 42 days by 4.1-13.8%.

The average concentration of corpuscular hemoglobin in the erythrocyte of broiler chickens of the experimental group increased by 6.3 and 0.28% at the age of 21 and 42
days, and at 14, 28 and 35 days became lower by 3.9–8.8% than that of the analogues in the control group.

**Table 1.** Dynamics of morphological parameters of broiler chickens’ blood when spirulina is introduced into the diet n=36

| Age of broiler chickens, days | Indicators (x±Sx), group |
|-----------------------------|-------------------------|
|                            | C          | E          | C          | E          | C          | E          | C          | E          |
|                            | Number of erythrocytes, 10^12/l | Number of hemoglobin, g/l | Hematocrit, % | Mean erythrocyte volume, fl | Mean corpuscular hemoglobin, g/l |
| 14                         | 1.28± 0.168 | 1.41± 0.173 | 95.25± 6.898 | 98.50± 3.697 | 16.20± 2.373 | 18.18± 2.144 | 126.98± 4.229 | 129.18± 3.151 | 598.00± 108.089 | 545.50± 55.872 |
| 21                         | 1.46± 0.353 | 1.56± 0.124 | 92.50± 25.199 | 100.25± 6.185 | 19.45± 5.171 | 19.83± 1.506 | 132.35± 7.231 | 126.93± 2.754 | 475.50± 33.201 | 505.25± 13.226 |
| 28                         | 1.62± 0.357 | 1.71± 0.045 | 101.50± 23.402 | 104.00± 4.690 | 20.00± 4.942 | 21.33± 1.124 | 145.13± 46.435 | 125.13± 7.414 | 510.25± 27.945 | 486.75± 12.580 |
| 35                         | 1.54± 0.090 | 1.74± 0.245 | 94.33± 12.055 | 103.67± 11.590 | 18.80± 2.007 | 21.53± 2.901 | 122.00± 6.655 | 123.93± 0.702 | 500.00± 19.698 | 480.67± 15.948 |
| 42                         | 2.02± 0.140 | 2.05± 0.378 | 117.67± 11.015 | 114.33± 19.296 | 24.73± 1.845 | 24.07± 4.500 | 122.67± 0.987 | 117.13± 4.366 | 475.33± 13.013 | 476.67± 25.541 |

Note (hereinafter): C - control group, E - experimental group of birds; * P ≤ 0.05; ** P ≤ 0.01; *** P ≤ 0.001.

The level of leukocytes in birds’ blood of the experimental group at the age of 14 days was higher relative to the control by 15.2% (P ≤ 0.001). This indicator slightly increased in the experimental group from 21 to 42 days age by 1.8-3.5% when compared with the birds’ control group (Table 2). The predominance of the content of leukocytes during the experimental study in the blood of birds of the experimental group compared with the control is due to the fact that phycocyanin isolated from spirulina improves the formation of antibodies and white blood cells [3, 14, 17, 25, 31, 34-35].

The proportion of various forms of leukocytes in the birds’ experimental and control groups during the experimental study changed ambiguously (Table 2).

In the broiler chickens’ blood of the experimental group, the percentage of % content of neutrophils at the age of 14 days was higher than that of the analogues of the control group by 4.4%, and this indicator reached its maximum value at the age of 42 days (62.80±10.624%), compared with the control group (30.80±16.150%) with a difference between the values of 32%.

In birds’ experimental group at the age of 21, 28 days compared with the control, the % content of neutrophils was lower by 8.3 and 5.9%, respectively, with a significant decrease in this indicator by 27.1% at the age of 35 days in the birds’ experimental group compared with the control.

The proportion of % content of lymphocytes in of experimental broiler chickens’ blood at the age of 14 and 35 days exceeded the control values by 9.5 and 2%, respectively. At the age of 21 days this difference was maximum and amounted to 45.85±7.659% versus 11.40±8.133%, which is higher by 34.5%. The decrease in the considered indicator in the chickens’ blood of the experimental group was established at the age of 28 and 42 days – by 6.3 and 4% respectively.

At the age of 28 and 35 days in the broiler chickens’ blood treated with spirulina biomass, the proportion of % content of eosinophils was higher by 12.7 and 25.5% compared to the control. At the age of 14, 21 and 42 days the proportion of % content of
eosinophils in the blood of broiler chickens of the experimental group in relation to analogues of the control group decreased by 13.5-28.4%.

Table 2. Spirulina effect on the morphological parameters of the broiler chickens’ blood n=36

| Age of broiler chickens, days | Indicators (x±Sx), group |
|------------------------------|-------------------------|
|                              | Leukogram, %             |
|                              | Neutrophils | Lymphocytes | Eosinophils | Basophils |
|                              | C          | E          | C          | E          | C          | E          | C          | E          |
| 14                           | 51.92± 6.532 | 59.80± 4.219*** | 33.75± 14.346 | 38.10± 11.914 | 26.30± 11.543 | 35.80± 20.429* | 38.48± 17.044 | 25.00± 10.898** | 1.48± 0.403 | 1.10± 0.294** |
| 21                           | 51.05± 21.911 | 52.80± 4.612** | 44.08± 11.437 | 35.78± 6.766** | 11.40± 8.133 | 45.85± 7.659*** | 42.58± 12.902 | 17.45± 1.605*** | 1.95± 0.705 | 0.90± 0.082*** |
| 28                           | 47.38± 16.858 | 48.22± 9.161** | 35.13± 6.727 | 29.23± 6.802** | 19.75± 18.206 | 13.43± 6.579 | 43.58± 23.582 | 56.30± 7.562* | 1.55± 0.635 | 1.05± 0.557** |
| 35                           | 41.76± 8.912 | 43.17± 9.996** | 56.63± 10.358 | 29.53± 11.249** | 16.63± 8.391 | 18.63± 2.608** | 25.10± 8.762** | 50.60± 13.835*** | 1.63± 0.611 | 1.17± 0.153** |
| 42                           | 51.16± 5.869 | 52.95± 11.947** | 30.80± 16.150 | 62.80± 10.624** | 16.87± 8.225 | 12.83± 5.001 | 51.27± 21.356 | 22.87± 7.357** | 1.03± 0.473 | 1.43± 0.306* |

During the period from 14 to 35 days the proportion of % of the content of basophils in the blood of broiler chickens of the experimental group decreased by 0.4-1.05% in relation to the control, and by the age of 42 days this indicator in the experimental group was higher than the control by 0.4%.

The number of neutrophils in the blood of broiler chickens treated with spirulina biomass at the age of 14 and 42 days was higher by 27.1 and 107.3%, respectively, compared with the control [14, 17] (Table 3).

Table 3. Age-related changes in the morphological parameters of the broiler chickens’ blood of n=36

| Age of broiler chickens, days Group | Indicators (x±Sx), group |
|-----------------------------------|-------------------------|
|                                   | Number of neutrophils, 10^9/ | Number of lymphocytes, 10^9/ | Number of eosinophils, 10^9/ | Number basophils, 10^9/ | Number of platelets, 10^9/ |
|                                   | C          | E          | C          | E          | C          | E          | C          | E          | C          | E          |
| 14                                | 18.10± 6.939 | 23.00± 8.193* | 14.49± 7.241 | 21.32± 12.564* | 21.19± 9.896 | 14.83± 6.429* | 0.79± 0.185 | 0.66± 0.211* | 4.75± 0.957 | 5.00± 1.826 |
| 21                                | 23.68± 12.995 | 18.84± 3.370** | 5.74± 4.646 | 24.32± 5.337*** | 20.75± 9.006 | 9.16± 0.391*** | 0.89± 0.182 | 0.47± 0.026*** | 3.25± 1.500 | 1.25± 0.500*** |
| 28                                | 16.20± 5.858 | 14.13± 4.327** | 7.19± 3.566 | 6.04± 2.555 | 23.24± 14.702 | 27.52± 8.423 | 0.73± 0.433 | 0.53± 0.398 | 2.50± 1.915 | 3.25± 2.500 |
| 35                                | 24.27± 9.257 | 12.34± 3.971** | 6.64± 3.234 | 8.03± 1.951 | 10.15± 2.600 | 22.29± 10.033** | 0.70± 0.393 | 0.49± 0.070 | 1.67± 0.577 | 1.33± 0.577 |
| 42                                | 15.65± 8.680 | 32.44± 2.574** | 8.89± 4.825 | 7.02± 3.422 | 26.09± 11.421 | 12.69± 6.586* | 0.51± 0.208 | 0.76± 0.280* | 2.67± 2.887 | 3.67± 2.082 |
4 Conclusions

The use of spirulina biomass as part of the compound feed led to an increase in the number of erythrocytes, hematocrit, leukocytes, hemoglobin concentration in the birds’ blood of the experimental group during the experiment. The number and % content of agranulocytes, granulocytes, platelets, the average volume of erythrocytes and the average concentration of corpuscular hemoglobin in birds’ erythrocytes in the experimental group is characterized by uneven changes. Hematological studies revealed that in the birds’ blood of the experimental group by 42 days age, there was an increase in the number of neutrophils, basophils, platelets and an increase in the proportion % of the content of neutrophils and basophils, and the number of lymphocytes, eosinophils and the proportion of their % content decreased.

References
1. B.F. Bessarabov. Livestock in Russia 3, 17-18 (2009)
2. L.N. Biktulov, O.N. Pavlova, N.N. Zhelonkin, E.A. Voishcheva, S.V. Pervushkin, P.P. PURYGIN, M.O. Tarkhova, Proceedings of the Samara Scientific Center of the Russian Academy of Sciences 2 193-197 (2008)
3. E.A. Voishcheva, V.V. Zaitsev, Effect of a dietary supplement based on spirulina on hematological parameters in rats, V: Modern scientific trends in animal husbandry, Kirov. 64-66 (2009)
4. E.A. Gribanova, O.N. Pavlova, N.N. Zhelonkin, E.A. Voishcheva, S.V. Pervushkin, P.P. PURYGIN, M.O. Tarkhova, Proceedings of the Samara Scientific Center of the Russian Academy of Sciences 2, 202-205 (2008)
5. Yu.Ya. Kavardakov, V.M. Romanov, Effect of bentonite on the morphological parameters of the of laying hens’ blood, V: Natural Science and Humanism. The Modern World, Nature and Man: Collection of Scientific Papers, 72–73 (2008)
6. S.A. Kedik, E.I. Yartsev, N.V. Gultyaeva, Spirulina - food of the XXI century, 166 (Pharma Center, Russia, 2006)
7. G.F. Lakin, Biometrics textbook for universities and pedagogical institutes, 352 (Higher School, Russia,1990)
8. I.A. Lykasova, E.N. Milogorodsky, The use of spirulina platensis in the diets of birds. Collection of abstracts of the 2nd Congress of the Russian Society of Pharmacologists «Fundamental Problems of Pharmacology», Moscow 308 (2003)
9. O.A. Matveev, A.A. Torshkov, Influence of spirulina in compound feed on the of broiler chickens’ productive qualities, Scientific support for the development of animal husbandry in the Russian Federation, Proceedings of the international scientific-practical conference dedicated to the 90th anniversary of the VIZh Academician L.K. Ernst, Dubrovitsy, 308-311 (2019)
10. O.A. Matveev, A.A. Torshkov, Izvestia OGAU, 6 (74), 179-182 (2018)
11. O.A. Matveev, A.A. Torshkov, Scientific notes of the KGAVM. N.E. Bauman, 241(1), 138-142 (2020)
12. O.A. Matveev, A.A. Torshkov, E.A. Disyuk, Scientific Bulletin of the State Educational Institution of the LNR LNAU, 8(1), 25-32 (2020)
13. I.V. Nasonov, N.V. Buyko, R.P. Lizun, V.E. Volykhina, N.V. Zakharik, S.M. Yakubovsky, Minsk, Republic of Belarus, 32 (2014)
14. O.N. Pavlova, Izvestia SGSKhA, 1, 36-38 (2012)
15. O.N. Pavlova, E.V. Kolesnikov, Substantiation of the use of a feed additive based on the biomass of spirulina and sesame seed meal in the cultivation of broiler chickens, Sofia: "Byal GRAD-BG" OOD, 88-91 (2012).
16. O.N. Pavlova, I.P. Tokarev, Izvestia SGSKhA, 1, 119-122 (2011)
17. O.N. Pavlova, S.A. Simakova, The use of feed additives of natural origin in the cultivation of poultry as a way to preserve human health. Medico-physiological problems of human ecology, Proceedings of the IV All-Russian Conference with international participation (September 26-30, 2011), Ulyanovsk, 242-244 (2011).
18. O.N. Pavlova, N.N. Zhelonkin, E.A. Voishcheva, S.V. Pervushkin, P.P. Purygin, M.O. Tarkhova, Proceedings of the Samara Scientific Center of the Russian Academy of Sciences, 2, 249-252 (2008)
19. V.V. Petryakov, New Science: Experience, Traditions, Innovations, 1-2 (59), 48-50 (2016)
20. V.V. Petryakov, Growth, development and productivity of broiler chickens when spirulina microalgae suspension is included in the diet. New Science: Current State and Ways of Development. International scientific periodical based on the results of the International Scientific and Practical Conference, 3, 17-19 (2016)
21. P.P. Purygin, N.N. Zhelonkin, O.N. Pavlova, S.V. Pervushkin, V.A. Kurkin, Yu.L. Gerasimov, T.Yu. Boronets, Bulletin of SamSU Natural Science Series, 6 (56), 393-400 (2007)
22. E.A. Sizova, Sh.G. Rakhmatullin, N.Yu. Chursina, O.V. Boyarova, R.R. Ibryaeva, Vestnik OGU. 6, 340-343 (2009)
23. A.A. Torshkov, Izvestia OGAU, 28 (1), 204-206 (2010)
24. A.A. Troshkov, Izvestia OGAU 6 (44), 220-222 (2013)
25. H.A. Al-Batshan, S.I. Al-Mufarrej, A.A. Al-Homaidan and M.A. Qureshi J Immunopharmacol and immunotoxicol. 23, 281-289 (2001)
26. A.S. Babadzhanov, N. Abdusamatova, F.M. Yusupova, N. Fayzullavea, L.G. Ezhlimyan, M.K. Mailkova, J Chemistry of Natural Compounds, 40, 276-279 (2004)
27. N.A. Badway, Nutrition and immune performance in poultry: Role of vitamin and Trace Minerals as Immune Boosters, Review Article, (Personal communication) (1998)
28. I. Bartove, J. Kanner, J Poult Sci. 75, 1039-1046 (1996)
29. C. Girardin-Andreani, J Phytotherapie, 4, 158-161 (2005)
30. A.B.M.R. Jamil1, Md.R. Akanda1., Md.M. Rahman, Md.A. Hossain1, and Md. S. Islam1, J. Adv. Vet. Anim. Res. 2, 3, 304-309 (2015)
31. Z. Khan, P. Bhadouria, P.S. Bisen, J Current Pharmaceutical Biotechnology, 6, 373-379 (2005)
32. Y.A. Mariey, H.R. Samak, M.A. Ibrahim, Egypt. Poult. Sci. J. 32, 201-215 (2012)
33. F.F. Mohamed, Egypt. Poult. Sci. J. 18, 443-448, (1998)
34. M. Qureshi, R.A. Ali, J Immunopharmacol and immunotoxicol. 18, 3, 457-463 (1996)
35. M.A. Qureshi, J.D. Garlich, M.T. Kidd, Immunopharmacol and Immunotoxicol. 18, 3, 465-476 (1996).
36. B. Shanmugapriya, S.B. Saravana, Indian Streams Res. J. 4 (3), 1-7 (2014)
37. A. Belay, M.E. Gershwin, Spirulina in human nutrition and health, IL (USA), CRC Press, 312 (2008)
38. Ö. Tokuşoğlu, M.K. Ünal Biomass, J of Food Science. 68, 1144-1148 (2003)