Features of growth, development and main indicators of bloodin chickens of Hubbard Redbro M dual-line cross

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Abstract. The use of active carbon additive (ACA) in the diet of in chickens of Hubbard Redbro M dual-line cross and its effect on their growth and the main blood parameters is reflected in the article. Feeding ACA gives a significant increase in live weight (3.5 – 7.5 %) during the growth period. RBC and WBC in the experimental group are within the physiological norm. The index of serum bactericidal activity in relation to the \(S.\ aureus\) test-culture in serum dilution 1:10 is higher in experimental group. Starting with the phase of logarithmic growth of test culture after a three hour exposure in the dilution of 1:5 is approximately the same in both groups. Serum bactericidal activity in \(E.\ coli\) test-culture is higher in control samples than in experimental ones in serum dilution is 1:5 higher than in dilution of 1:10. The data obtained are confirmed by an indicator of the intensity of serum bactericidal activity: the difference between the experimental and control groups vary from 2.1 to 5.6 abs. %. There is a positive relationship between indicators of serum bactericidal activity on the background of the studied test-cultures. At the dilution of serum in chickens of control group 1:10 correlation of serum bactericidal activity with the index in the experimental group were not observed.

1. Introduction
Organic agriculture is a leading global trend [1]. The safety and environmental friendliness of food products are important factors in agricultural production. The external factors such as the use of chemical feed additives, the use of drugs and antibiotics, etc. are of great importance in the poultry production [2].

Mineral sorbents stimulate the processes that cleanse the body of animals and birds from a number of toxins: xenobiotics, heavy metals, metabolic products of pathogenic microflora [3]. Feldspar, quartz, mica and clay contains related minerals that are used as sorbents [4]. Natural sorbents are biologically active; affect metabolism and vital activity of the whole organism of farm animals. Their
effect appears in the gastrointestinal tract and is due to buffer, ion exchange and sorption properties [5].

The active carbon additive (ACA) made on the basis of charcoal belongs to the preparations of sorption action of natural origin.

The aim of the research was to study the use of ACA in the diet of broiler chickens and its effect on their growth and the main blood parameters.

2. Materials and methods

The Hubbard Redbro M dual-line cross chickens were used in the experiment. 60 heads total: 30 heads in control group and 30 heads in experimental one. The experiment lasted for 58 days. Water and feed was available ad libitum. The experimental group received 1 kg of ACA per 1 ton of feed. Both groups of chickens received the common diet. The safety of the chickens of the control group during the experimental period was 90.0%, and of the experimental one – 93.3%.

Growth (live weight in grams) and development indicators have been studied. The next indicators of development are represented below.

Absolute increase (A) in live weight (in grams):

\[ A = \frac{W_t - W_0}{t}, \]

where: \( W_0 \) is the initial mass (g) of the chicken; \( W_t \) is the live weight of the chicken at the end of the period; \( t \) is the time of the period of research.

Growth rate (GR) is the value of the growth rate of the animal, expressed as a percentage of its mass at the beginning (\( W_0 \)) and at the end (\( W_t \)) of the research (expressed in %):

\[ GR = \frac{W_t - W_0}{W_0} \times 100\% \]

Relative weight gain (RWG) is expressed as a percentage of the half-sum of the initial (\( W_0 \)) and final (\( W_t \)) mass. The RWG was calculated as (expressed in %):

\[ RWG = \frac{W_t - W_0}{0.5 \times (W_t - W_0)} \times 100\% \]

The content of red blood cells (RBC), white blood cells (WBC) and differential leukocyte count (DLC) was studied.

Serum bactericidal activity of chickens’ blood was determined. Test-cultures: \( S. \) aureus and \( E. \) coli. Two dilutions of blood serum 1:5 and 1:10 were used in the experiment. In the control variants, instead of blood serum, the same volumes of isotonic sodium chloride solution were taken. The 96-well plate was placed in a Multiskan FC reader, and the optical density of the growing cultures was measured every hour during 24 hours. Serum bactericidal activity was determined by the formula (expressed in %):

\[ Serum \ bactericidal \ activity = 100 - \frac{100 \times D_t - D_c}{D'_t - D'_c}, \]

where: \( D_t \) – is the optical density in 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 h; \( D_c \) – optical density before thermostat; \( D'_t \) – optical density of control after 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 h; \( D'_c \) – optical density of control before placement in the thermostat; \( t \) – exposure time cuvette in thermostat, h.

Based on Serum bactericidal activity calculated the intensity of the bactericidal activity of serum by the formula:

\[ Intensity \ of \ the \ bactericidal \ activity \ of \ serum = \frac{\sum AnTn}{\Sigma Tn} = \frac{A1T1 + A2T2 + \ldots + AnTn}{T1 + T2 + \ldots + Tn}, \]
where: \( A_1, A_2, \ldots, A_n \) - bactericidal activity of blood serum after 1, 2, \( \ldots \), \( n \) h, %; \( T_1, T_2, \ldots, T_n \) - the duration of temperature control, h.

All indicators were statistically processed. The software package Statistica.10 was used for analysis.

### 3. The study of the active carbon additive in the diet of broiler chickens

Feeding of the ACA to Hubbard Redbro M dual-line cross chickens increased the live weight by 2.5% on the tenth day of the experiment; on the 20th day – by 3.4%; at the age of 30 days by 3.1% (\( p \leq 0.95 \)), at the age of 40 days by 3.5% (\( p \leq 0.95 \)), at the age of 50 days by 7.5% (\( p \leq 0.99 \)) and before slaughter (at the age of 58 days) by 4.5% (\( p \leq 0.999 \)) (Table 1).

#### Table 1. Features of growth of Hubbard Redbro M dual-line cross chickens in the experiment

| Day of life | Control group | Experimental group |
|-------------|---------------|-------------------|
|             | \( X \pm S_X \) | \( X \pm S_X \) | \( C_v \) | \( C_v \) |
| 1st         | 40.60±0.31    | 40.52±0.32       | 3.8     | 4.0     |
| 10th        | 151.4±2.98    | 155.2±2.53       | 9.8     | 8.1     |
| 20th        | 416.0±6.91    | 430.40±4.32      | 8.3     | 5.0     |
| 30th        | 716.8±6.23    | 739.20±5.68*     | 4.3     | 3.8     |
| 40th        | 932.6±8.22    | 965.6±11.14*     | 4.4     | 5.8     |
| 50th        | 1455.0±25.7   | 1563.6±17.6**    | 8.8     | 5.6     |
| 58th (before slaughter) | 2075.6±15.0 | 2170.0±10.7*** | 3.6 | 2.5 |

The absolute increase in live weight in the experimental group is 36.7 g, on average, which is 1.6 g higher compared to the control group. Average values of the relative weight gain during the experiment are 247.6 % more at experimental group. Growth rate of the experimental group is 0.3 % higher. Figure 1 shows the dynamics of these three indicators during periods of weighing chickens of both groups.

![Figure 1. Features of development of Hubbard Redbro M dual-line cross chickens in the experiment](image)
Figure 2. 3D surface plot that shows the relationship of growth rate, absolute increase in live weight and relative weight gain of chickens as a 3D model

3D surface plot of growth rate compared to absolute increase in live weight and relative weight gain of chickens of both groups was built (Figure 2). The equations of interaction of these features were constructed, where $x$ is absolute increase in live weight and $y$ is relative weight gain. For chickens in the control group: \[ \text{growth rate} = 11.0676 - 0.996x + 1.1489y + 0.0172xx - 0.0064xy - 0.0024yy. \] For chickens in the experimental group: \[ \text{growth rate} = 4.8774 - 0.4062x + 1.0664y + 0.0089xx - 0.0062xy - 0.0021yy. \]

The content of RBC and WBC was stated in Table 2. RBC in the experimental group was 17.9 \% more or $0.40 \times 10^{12} /L$: the difference is significant. There were also 9.1 \% more of WBC in the experimental group, but the difference is not significant.

Table 2. Main elements in the blood of chickens

|                | Experimental group | Control group |
|----------------|--------------------|---------------|
| $\overline{X} \pm S_{\overline{X}}$ | $2.66 \pm 0.13^*$ | $28.00 \pm 1.92$ |
| $\delta$      | 0.23               | 3.33          |
| $C_r$, \%     | 8.7                | 11.9          |

DLC indicates the absence of inflammation or metabolic disorders in the body of chickens (Figure 3).

Figure 3. DLC of Hubbard Redbro M dual-line cross chickens (\%)

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Serum bactericidal activity of Hubbard Redbro M dual-line cross chickens blood was determined. Results are presented in Tables 3 and 4.

**Table 3.** Serum bactericidal activity of Hubbard Redbro M dual-line cross chickens blood. Test-culture is S. aureus (%)

| Incubation time (hours) | Control group | Experimental group |
|-------------------------|---------------|--------------------|
|                         | Serum dilution | Serum dilution     |
|                         | 1:10          | 1:5                |
|                         | 1:10          | 1:5                |
| 0                       | –             | –                  |
| 1                       | +15.8         | +29.4              |
| 1                       | +1.5          | +100               |
| 2                       | - 11.9        | - 33.8             |
| 2                       | +21.1         | - 24.3             |
| 3                       | - 5.1         | - 25.6             |
| 3                       | +26.4         | - 25.1             |
| 4                       | + 20.2        | - 11.9             |
| 4                       | +29.4         | - 24.3             |
| 5                       | + 26.6        | - 47.4             |
| 5                       | - 17.7        | - 17.7             |
| 6                       | + 26.7        | - 14.2             |
| 6                       | +21.1         | - 18.6             |
| 7                       | + 27.6        | - 11.8             |
| 7                       | +29.9         | - 11.4             |
| 8                       | + 16.2        | - 29.3             |
| 8                       | - 13.3        | - 13.3             |
| 9                       | +11.7         | - 28.4             |
| 9                       | - 10.8        | - 10.8             |
| 10                      | +19.6         | - 25.0             |
| 10                      | - 10.1        | - 10.1             |

Serum bactericidal activity in Hubbard Redbro M dual-line crosses chickens in a dilution of 1:10 in relation to test-culture S. aureus in the control group varied from 11.7 to 27.6 %. Negative values were marked at the second and third hours of exposure. Serum bactericidal activity of control animal varied from 1.5 % at the beginning to 25.0 % at the end of exposure. The average intensity of the bactericidal activity of serum from the control group at a 1:10 dilution was 2.7, and at a dilution of 1:5 – - 2.6 units. When serum of the control group was diluted 1:5 in the medium of S. aureus, serum bactericidal activity ranged from 29.4 to -9.1 %, and in the experimental group – from 100 % decreased to -10.1 %. The average intensity of the bactericidal activity of serum in the dilution 1:10 in the experimental group was 4.3, and control was -0.5 units.

**Table 4.** Serum bactericidal activity in Hubbard Redbro M dual-line cross chickens blood. Test-culture is E. coli (%)

| Incubation time (hours) | Control group | Experimental group |
|-------------------------|---------------|--------------------|
|                         | Serum dilution | Serum dilution     |
|                         | 1:10          | 1:5                |
|                         | 1:10          | 1:5                |
| 0                       | –             | –                  |
| 1                       | +95.7%        | +55.7              |
| 1                       | +91.3         | +45.0              |
| 2                       | +94.2         | +81.2              |
| 3                       | +94.5         | +68.7              |
| 4                       | +89.6         | +65.1              |
| 5                       | +89.7         | +62.5              |
| 6                       | +90.9         | +57.4              |
| 7                       | +91.1         | +57.9              |
| 8                       | +86.7         | +55.6              |
| 9                       | +72.1         | +52.0              |
| 10                      | +47.4         | +49.9              |

Serum bactericidal activity in 1:10 dilution on the background of test-culture E. coli in the control group during decadal incubation varied from 95.7 to 51.0%, and in the experimental one – from 55.7 to 22.5 %. The average tension of serum bactericidal activity in the control group was 11.1 and 15.6 units at a serum dilution 1:10 and 1:5, respectively. When diluting serum 1:5 its bactericidal properties...
against test-culture *E. Coli* in the control group gradually reduced from 100.0 to 47.4 %, and in the experimental one – from 94.1 to 49.9 %. The average intensity of the bactericidal activity of serum at the experimental group was 5.5 and 11.7 units at a serum dilution 1:10 and 1:5, respectively.

Thus, the indicator of serum bactericidal activity depends on the used test-culture (*S. aureus* or *E. coli*) and differs in the control and experimental groups. A similar pattern is noted in the studies of Malyov [6]. The value of the average intensity of bactericidal activity is also different in the studied groups: the difference between serum bactericidal activity and control analogs varied from 1.6 – 5.6 abs. % with a diluting of serum 1: 10, and with a diluting 1: 5 – from 2.1 to 3.9 abs. % in the experimental group.

**Table 5.** Correlations of indicators of Serum bactericidal activity between groups of Hubbard Redbro M dual-line cross chickens

| Group   | Serum dilution | Control | Experimental |
|---------|----------------|---------|--------------|
|         | 1:10           | 1:5     | 1:10         |
| **Test culture is *S. aureus*** |               |         |              |
| Control | 0.39±0.28      |         |              |
| Experimental | 0.75±0.15*** | 0.87±0.08*** |              |
|           | 0.01±0.15      | 0.88±0.88*** | 0.60±0.21*       |
| **Test culture is *E. coli*** | |         |              |
| Control | 0.07±0.33      |         |              |
| Experimental | -0.38±0.29 | 0.53±0.24* |              |
|           | -0.24±0.31      | 0.66±0.19** | 0.95±0.03***       |

The interrelation of indicators of serum bactericidal activities between groups of Hubbard Redbro M dual-line cross chickens was shown in table 5. Serum bactericidal activity index in relation to *S. aureus* for chickens of the control group 1: 10 dilution serum is characterized by a high positive correlation in comparison with the experimental group (*r*=0.75±0.15). Similar pattern exists when serum is diluted 1:5 (*r*=0.87±0.08 and 0.88±0.88).

As for *E. coli* cultures, a positive correlation of the serum bactericidal activity indicator in control and experimental groups was also noted both at dilution of 1:10 (*r*=0.53±0.24) and 1:5 (*r*=0.66±0.19).

A positive and reliable relationship between the serum bactericidal activity value (*p*≤0.05; *p*≤0.001) was observed for chickens of the experimental group at a dilution of serum 1:10 compared to the serum bactericidal activity of control group at a dilution of 1:5. These indicators are *r*=0.60±0.21 (with test-culture *S. aureus*) and *r*=0.95±0.03 (with test-culture *E. coli*), respectively.

4. Conclusion

Active carbon additive to Hubbard Redbro M dual-line cross chickens gives a significant increase in live weight (3.5 – 7.5 %) during the growth period. Hematological parameters such as the content of RBC and WBC in the experimental group are within the physiological norm. But the number of RBC in the experimental group is significantly higher than in the control one (by 0.40 ×10¹² cells per L).

The index of serum bactericidal activity in relation to the *S. aureus* test-culture in serum dilution 1:10 is higher in experimental group. Starting with the phase of logarithmic growth of test culture after a three hour exposure in the dilution of 1:5 is approximately the same in both groups. Serum bactericidal activity in *E. coli* test-culture is higher in control samples than in experimental ones in serum dilution is 1:5 higher than in dilution of 1:10. The data obtained are confirmed by an indicator of the intensity of serum bactericidal activity: the difference between the experimental and control groups vary from 2.1 to 5.6 abs. %.
There is a positive relationship between indicators of serum bactericidal activity on the background of the studied test-cultures. At the dilution of serum in chickens of control group 1:10 correlation of serum bactericidal activity with the index in the experimental group were not observed.

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