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# Modern Development Paths of Agricultural Production

## Trends and Innovations



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| Abstract | The peculiarities of the effect of bioflavonoids extract of oat seedlings on the state of prooxidant–antioxidant equilibrium in liver tissues of geese in the pre-slaughter period were clarified. It has been proved that oat extract stabilizes this equilibrium throughout the research period, and during the physiological stress of the formation of juvenile feathers, it promotes activation of the antioxidant system of the liver of geese. The results of the correlation and cluster analysis show that the activation of the antioxidant defense system is the result of the inclusion of alternative mechanisms that are characterized by a 25.0% lower level of consistency of the components of the antioxidant defense system. The increase in the average weight of the 63-day geese of the experimental group by almost 20.0% compared with control is an additional confirmation of the increase in the antioxidant status of geese under the influence of oats extract. |
| Keywords (separated by '-') | Geese - Liver - Antioxidant system - Oat seed extract - Correlation - Cluster analysis |

# Influence of Oat Seed Extract Bioflavonoids on the Antioxidant Status of Geese

**Olena Danchenko, Lubov Zdorovtseva, Mykola Danchenko, Oleksandr Yakoviichuk, Tetiana Halko, Elena Sukharenko and Yulia Nicolaeva**





## 1 Introduction

Poultry farming is one of the most developed livestock industries in many countries around the world. In Ukraine, the traditional direction of poultry farming is geese breeding. However, recently, for a number of reasons, the number of geese in the country has decreased. So, from 1990 to 2015, the parental population of geese in Ukraine declined by almost 2.5 times [1–5]. However, an analysis of the condition and prospects for the development of the geese population indicates that there are basic prerequisites for the restoration of this industry in Ukraine. This is, first of all, the preserved gene pool of geese and favorable climatic conditions for geese in most regions of Ukraine [6, 7]. The use of innovative technologies and modern technological equipment in the poultry industry and the introduction of scientific achievements in production will contribute to increasing the efficiency of this industry [8, 9].

The use of antioxidants in feeding birds helps to eliminate the harmful effects of negative anthropogenic factors of the existing technologies for its cultivation [10]. Using natural antioxidant impurities has a number of advantages over the traditional synthetic vitamins of the antioxidant group. They are generally available, side effects are minimal or absent, they are not likely to cause toxic organic slags, do not irritate the mucous membrane of the stomach, do not disturb the digestion, and that is why they are well tolerated [11–15].

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**The aim of this work** was to find out the effect of the extract of oat seeding Avéna satíva on the antioxidant activity of the liver tissues of geese of the Italian breed in the pre-slaughter period (from the 35th to the 63rd day).

# 2 Experimental Studies

## *2.1 Research Method and Materials*

The research was carried out on geese of the Italian breed on the basis of the "Victoria" agricultural enterprise of Priazovsky district of Zaporizhzhya region. At the age of 1 day, based on the principle of analogs, two groups of geese (control and experimental) were formed with 26 geese in each group with an average weight (98.5 ± 4.2) g. Throughout the experiment, the birds of the control group were kept on a standard diet balanced by exchange energy, protein, and vitamins in accordance with the recommendations [16]. The geese of the experimental group from the 35th to the 56th day were given an oat extract. The geese of the experimental group were given an oat extract diluted by 5.0 times. Slaughter of geese was carried out at 63 days of age, following the standards of the Council of Europe Convention on the protection of animals used in scientific research.

During the experiment, weekly determination of the intensity of lipid peroxide oxidation (LPO) in geese liver tissues was carried out, which was evaluated by the content of peroxidation products reacting with 2-tiobarbituric acid in the homogenates of these tissues (TBCAPout) and after the initiation of $Fe^{2+}$ POL (TBCAPin) [17]. The state of the AOP system was determined using the integral index—the antioxidant activity factor ($C_{AOA}$) [18], which was calculated as the ratio of TBCAPout to TBCAPin, since tissues homogenates contain not only the peroxidation substrate but also AOP components that can inhibit lipid peroxidation. In addition, in the isolated biomaterial, the content of total lipids, vitamins E, A, β-carotene, and antioxidant enzymes: superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (HPO) [19–21] was determined. Mathematical processing of research results was carried out by methods of mathematical statistics, including multidimensional correlation and cluster analysis, using the SPSS-13.0 computer software package and MS Excel 2000 software.

## *2.2 Results and Discussion*

The indicated interval of geese ontogenesis is characterized by physiological stress in the body of birds (from the 42nd to the 56th day) caused by the formation of juvenile feathers. This process requires high energy and amino acids, including sulfur-containing ones. Therefore, even on the background of a balanced diet for energy

**Table 1** The content of lipids, lipoperoxidation products, and the antioxidant activity in the geese liver ($M \pm m$, $n = 6$)

| Age, days, $T$ | Group | TBCAPout ($P_2$), nMol/g | TBCAPin ($P_3$), nMol/g | Lipids ($X$), mg/g | $C_{AOA}$ |
|---|---|---|---|---|---|
| 35 | Control | $62.5 \pm 3.8$ | $124.7 \pm 6.2$ | $21.8 \pm 1.3$ | 0.50 |
| | Experimental | $63.3 \pm 3.4$ | $126.3 \pm 4.9$ | $22.7 \pm 1.1$ | 0.50 |
| 42 | Control | $87.2 \pm 4.0$ | $182.3 \pm 7.5$ | $17.3 \pm 0.7$ | 0.48 |
| | Experimental | $61.7 \pm 2.8^{*}$ | $121.0 \pm 5.3^{**}$ | $18.2 \pm 0.4$ | 0.51 |
| 49 | Control | $93.5 \pm 4.7$ | $283.2 \pm 12.7$ | $14.1 \pm 0.8$ | 0.33 |
| | Experimental | $84.2 \pm 3.8$ | $187.1 \pm 8.4^{**}$ | $14.8 \pm 0.7$ | 0.45 |
| 56 | Control | $71.3 \pm 3.5$ | $169.8 \pm 9.3$ | $12.2 \pm 0.5$ | 0.42 |
| | Experimental | $54.1 \pm 2.2^{**}$ | $102.1 \pm 5.7^{**}$ | $11.9 \pm 0.6$ | 0.53 |
| 63 | Control | $57.8 \pm 2.8$ | $118.0 \pm 4.7$ | $9.8 \pm 0.3$ | 0.49 |
| | Experimental | $49.8 \pm 2.3^{*}$ | $87.4 \pm 3.8^{*}$ | $10.7 \pm 0.5$ | 0.57 |

*Note* Here and in Table 2, the difference is probably relative to the control group: $^{*}$—$p \leq 0.05$; $^{**}$—$p \leq 0.01$

and protein, the process of juvenile fever formation is accompanied by stress in the AOP system, which is reflected in an increase in the content of lipoperoxidation products in the liver of the 49-day-old geese of the control group compared with the starting value (TBCAPout by 50.0%, TBCAPin—by 2.27 times), while $C_{AOA}$ decreased accordingly by 34.0% (Table 1) . At the same time, the nature of the lipid content ($r = -0.895$, $\gamma = 0.002$) is monotonically declining during the experiment.

The physiological tension in the geese was characterized by a decrease in the level of activity of antioxidant enzymes: SOD (by 32.8%) and CAT (by 49.5%), vitamin E (by 26.5%), and β-carotene (by 19.6%) (Table 2). At the same time, the GPO activity from the 35th to the 56th day increased almost twice, and the vitamin A content was maintained at a presumably stable level. The second half of the experiment was accompanied by stabilization of the prooxidant–antioxidant equilibrium, which is confirmed by a decrease in the content of the products of the peroxide oxidation in the liver (TBCAPout at 38.2%, TBCAPin by 2.40 times), and the $C_{AOA}$ during this period increased by 48.5%. However, the activation of antioxidant enzymes of SOD and CAT at the end of the experiment was slowed down, and for 63-day-old geese, these figures were 26.9 and 44.8% inferior to their base value.

Under the influence of bioflavonoids of oats in the geese of the experimental group, there was a decrease in the average level of TBCAPout by 15.9%, TBCAPin by 28.9%, while the $C_{AOA}$ increased by 15.3%. In the second part of the experiment, a significant activation of CAT and an increase in the content of vitamin E and β-carotene were established in geese liver in the experimental group. However, it is probably more important that activation of the AOP system during physiological stress is observed in 49-day-old geese. It was at this age that the geese of the experimental group exceeded the corresponding index of the control group by 36.4%.

**Table 2** The activity of enzymes, the content of vitamins in the liver, and the live weight of geese ($M \pm m$, $n = 6$)

| Age, day, $T$ | Group | Activity of enzymes | | | Vitamin content µg/g | | | Mass of geese ($M$), kg |
|---|---|---|---|---|---|---|---|---|
| | | SOD ($Y_1$), con. un./(min g) | CAT × $10^{-5}$ ($Y_2$), nкat/g | GPO × $10^4$ ($Y_3$), mcmoles/(min g) | A ($V_1$) | E ($V_2$) | β-carotene ($V_3$) | |
| 35 | Control | 11.32 ± 0.63 | 17.09 ± 0.72 | 3.52 ± 0.17 | 4.32 ± 0.19 | 13.26 ± 0.53 | 10.86 ± 0.41 | 2.05 ± 0.11 |
| | Experimental | 11.47 ± 0.58 | 17.33 ± 0.81 | 3.52 ± 0.21 | 4.27 ± 0.21 | 12.98 ± 0.59 | 10.71 ± 0.63 | 2.12 ± 0.08 |
| 42 | Control | 10.25 ± 0.47 | 11.95 ± 0.73 | 4.81 ± 0.21 | 4.58 ± 0.14 | 12.93 ± 0.71 | 10.03 ± 0.42 | 2.46 ± 0.11 |
| | Experimental | 10.97 ± 0.61 | 13.43 ± 0.55 | 3.89* ± 0.19* | 4.02* ± 0.17 | 14.29 ± 1.07 | 11.32 ± 0.57 | 2.68 ± 0.09 |
| 49 | Control | 7.61 ± 0.41 | 10.30 ± 0.27 | 5.73 ± 0.27 | 4.17 ± 0.25 | 9.74 ± 0.21 | 9.32 ± 0.27 | 2.68 ± 0.14 |
| | Experimental | 8.04 ± 0.32 | 11.05 ± 0.42 | 6.98* ± 0.32 | 3.45* ± 0.23 | 10.63* ± 0.17 | 9.97 ± 0.34 | 2.91 ± 0.10 |
| 56 | Control | 9.21 ± 0.43 | 8.63 ± 0.28 | 6.79 ± 0.27 | 3.98 ± 0.15 | 10.79 ± 0.40 | 8.73 ± 0.24 | 2.95 ± 0.09 |
| | Experimental | 8.93 ± 0.51 | 10.65* ± 0.47 | 5.47* ± 0.29 | 4.72* ± 0.21 | 12.07* ± 0.19 | 9.64* ± 0.17 | 3.36* ± 0.13 |
| 63 | Control | 8.28 ± 0.39 | 9.43 ± 0.37 | 4.37 ± 0.19 | 4.41 ± 0.18 | 11.74 ± 0.37 | 9.78 ± 0.32 | 3.24 ± 0.12 |
| | Experimental | 8.65 ± 0.43 | 10.87* ± 0.48 | 5.73* ± 0.31 | 4.63 ± 0.25 | 13.95** ± 0.43 | 10.77* ± 0.29 | 3.88* ± 0.13 |

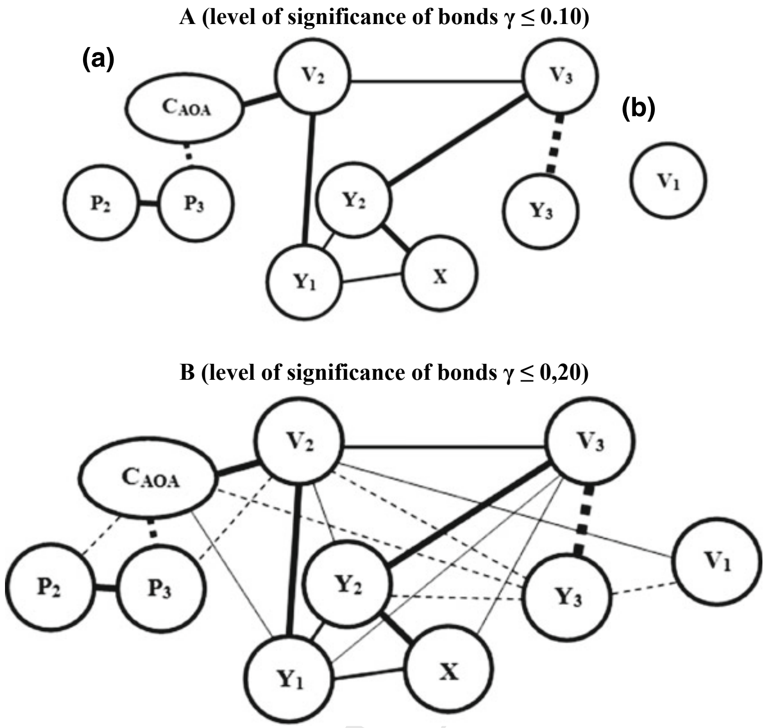


**Fig. 1** Clusters of the investigated parameters of the control group according to the density of their correlation bonds: – or - - - - at the level of significance $\gamma \leq 0.05$; – or - - - - at the significance level $\gamma \leq 0.01$; – or - - - - at the level of significance $\gamma \leq 0.10$; – or - - - - at the level of significance $\gamma \leq 0.20$

In addition, the effect of the extract is stabilization of the level of $C_{\text{AOA}}$, which is confirmed 1.86 times lower than the control group, the value of the coefficient of variation of the $C_{\text{AOA}}$. A significantly higher mass of 63-day-old geese of the experimental group compared with the control one (19.8%) is an additional confirmation of the activation of the AOP geese system under the influence of oats extract.

A cluster analysis was performed to find out the nature and order of the integrated structure of the investigated parameters of the prooxidant–antioxidant equilibrium. It provides a more visible view of the dependence of the antioxidant activity of liver tissues, quantitatively determined by the $C_{\text{AOA}}$, from the studied parameters. The clustering of these indices of the control group that is the basis of the quantity and density of the correlation links between them at the level of significance $\gamma \leq 0.10$ shows two clusters (Fig. 1A).

Within the framework of the nine clusters, which includes $C_{\text{AOA}}$, a strong influence of vitamin E on the level of $C_{\text{AOA}}$ ($r = 0.910$, $\gamma = 0.032$) attracts attention. All investigated enzymes and β-carotene exhibit a powerful but indirect influence on $C_{\text{AOA}}$. Meanwhile, vitamin A remains in isolation without any reliable correlation.

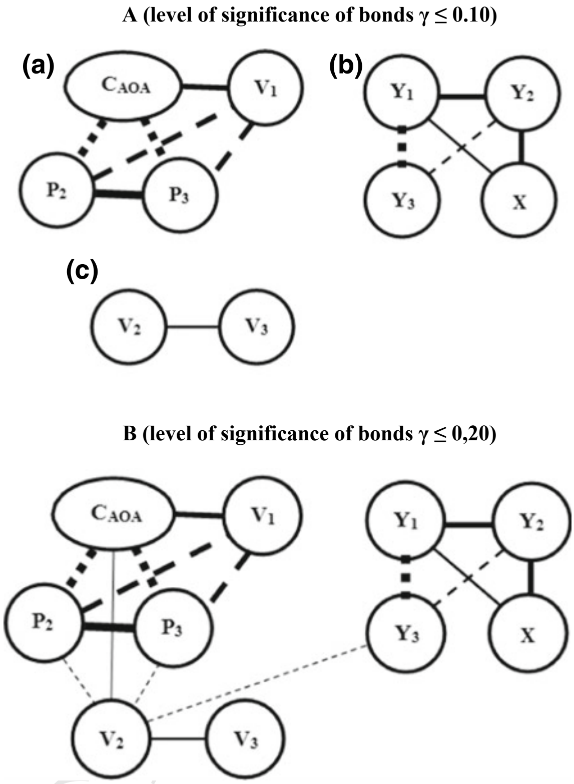


**Fig. 2** Clusters of the studied parameters of the experimental group on the density of their correlation bonds: – or - - - - at the level of significance $\gamma \leq 0.05$; – or - - - - at the significance level $\gamma \leq 0.01$; – or - - - - at the level of significance $\gamma \leq 0.10$; – or - - - - at the level of significance $\gamma \leq 0.20$

However, the correlation analysis of the investigated parameters of the control group at the level of significance $\gamma \leq 0.20$ (Fig. 1B) indicates a tendency to link vitamin A content with the GPO activity ($r = -0.709$, $\gamma = 0.180$) and the content vitamin E ($r = -0.688$, $\gamma = 0.199$) and, thus, the indirect ability to influence the $C_{AOA}$ liver of geese.

The clusterization of the experimental group ($\gamma \leq 0.10$) showed three clusters (Fig. 2A). Specificity of the functioning of the AOP system of the liver geese of the experimental group is 25.0% lower compared to the control group of the consistency of the studied prooxidant–antioxidant balance during the study period.

Attention is drawn to an increase in the direct and indirect effects of vitamin A on $C_{AOA}$. Meanwhile, vitamin E has a distinct position, indicating a weakening of its effect on $C_{AOA}$. Thus, due to the action of components of the oats extract in the liver tissues of the geese, alternative mechanisms of antioxidant protection, which are characterized by increasing the influence of vitamin A on antioxidant activity ($C_{AOA}$), are activated. Correlation analysis of the investigated indicators of the experimental group at the level of significance $\gamma \leq 0.20$ (Fig. 2B) proves the presence of a tendency to link the content of vitamin E with the $C_{AOA}$ ($r = 0.703$, $\gamma = 0.185$) and with the HPO activity ($r = 0.679$, $\gamma = 0.200$) and thus proves the existence of a single antioxidant system in which, depending on the nature of the influence of exogenous factors, various mechanisms are implemented with the predominant participation of individual components of the AOP system.

## 3 Conclusions

1. Introduction to the diet of geese extract of oat in the pre-slaughter period stabilizes the prooxidant–antioxidant balance in the tissues of their liver, and during physiological stress causes an increase in the antioxidant activity of these tissues, which is accompanied by a significant activation of CAT and an increase in the content of vitamin E and β-carotene in the liver geese.
2. Under the influence of oats extract, alternative mechanisms of antioxidant protection are included, which are characterized by 25.0% lower level of consistency of components of the AOP system.
3. The increase in the mass of the 63-day-old geese of the experimental group compared with the control of almost 20.0% is an additional confirmation of activation of the AOP geese system under the influence of oats extract.





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