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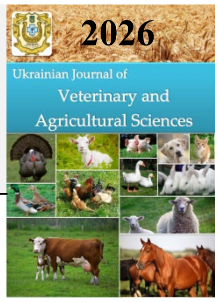

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Slaughter and meat quality of young ducks depending on selenium supplementation in compound feeds

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Contents

Abstract

The list of macro- and microelements currently used in compound feeds for various types of poultry is considered insufficient by many researchers. In recent years, applied scientific studies have been conducted to determine and refine the physiological requirements of different species and technological groups of poultry for certain mineral elements that perform important biochemical functions in the body. This also applies to such an essential trace element as selenium. It has been proven that the inclusion of selenium in compound feeds for poultry alters the direction of physiological and biochemical processes in the body, improves metabolism, and, as a result, contributes to increased egg production, body weight, viability, feed conversion, and product quality. In order to deepen and expand current knowledge about the biological role of selenium in the organism, its effect on productive traits and internal characteristics of poultry, comprehensive studies were conducted. One of the objectives was to investigate the effect of different selenium supplementation levels in compound feeds on the slaughter and meat qualities of young ducks. For the experimental study, four groups of one-day-old Ukrainian White ducklings were formed, 100 birds in each group. The duration of the experiment was 56 days, corresponding to the rearing period for meat production. Ducklings of the first (control) group did not receive selenium supplementation. Birds of the experimental groups were additionally provided with selenium in the following amounts (mg/kg): group 2 – 0.2; group 3 – 0.4; group 4 – 0.6. Analysis of the obtained results showed that among the experimental groups, the highest meat productivity was observed in ducks of the third group, which received feed supplemented with selenium at a level of 0.4 mg/kg. In this group, the weight of semi-eviscerated carcasses was higher by 6.3 % ($P < 0.001$), eviscerated carcasses by 6.7 % ($P < 0.01$), and edible parts by 10.7 % ($P < 0.01$) compared to the control group. The absolute and relative weights of edible parts increased mainly due to more intensive growth of muscle tissue and skin with subcutaneous fat, as well as better development of internal organs (heart, liver, gizzard). This was reflected in the ratio of inedible to edible parts, which in ducks of the third experimental group was 8.2 % higher than in the control group and amounted to 1:1.19. In other experimental groups, the absolute indicators of meat productivity were somewhat lower compared to the third group.

Keywords: selenium; dose; compound feed; ducklings; meat productivity.

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1. Introduction

Poultry farming is one of the fastest-growing sectors of animal production worldwide. It plays a crucial role in ensuring national food security, as it provides the population with high-quality and affordable food products, particularly eggs and meat, contributes to economic development, and supports the country's export potential (Harchaoui et al., 2023).

The production of maximum amounts of high-quality poultry products is possible only under conditions that take into account both biological and technological factors. It has been established that different species and crosses of poultry used in modern industrial production systems differ significantly in productivity levels, metabolic intensity, requirements for metabolizable energy, nutrients, and biologically active substances. At the same time, poultry are highly sensitive to the negative effects of technological stress factors, including high stocking density, dietary changes, fluctuations in microclimate conditions, vaccination, and transportation. These factors may lead to metabolic disorders, suppression of immunobiological reactivity, and, consequently, reduced productivity and product quality (Baéza et al., 2022).

Balanced nutrition is the most important factor affecting the growth, development, viability, and productivity of poultry. High productivity levels are associated with increased nutrient requirements. Therefore, feeding standards for poultry are periodically revised in accordance with local economic, environmental, and management conditions (Kumar et al., 2024).

Microelements are an essential component of complete compound feeds for poultry, performing diverse functions in the body, including catalytic, structural, and regulatory roles. They activate numerous enzymes, vitamins, and hormones, thereby ensuring the normal functioning of biological systems and supporting various physiological and biochemical processes (Byrne & Murphy, 2022).

Microelements cannot be synthesized in the body or replaced by other substances; therefore, feed is their primary source. The inclusion of optimal levels of microelements in compound feeds allows targeted regulation of metabolic processes in poultry. However, the physiological requirements of different poultry species for certain microelements have not yet been fully established. This also applies to such an essential trace element as selenium.

Selenium is a trace element with a broad spectrum of biological activity (Iftikhar et al., 2025; Moulick & Choudhury, 2025). Numerous studies have demonstrated that selenium possesses antioxidant (Aderao et al., 2025), immunostimulatory (Sadler et al., 2024), antitoxic (Sun et al., 2023), antiviral (Jain & Priyadarsini, 2024), radioprotective (Zhang et al., 2024), anticancer (Maleczek et al., 2024), adaptogenic (Ban et al., 2024), and other properties. At the same time, certain aspects of selenium's effects on the poultry organism remain insufficiently understood.

Early attempts to use selenium as a mineral supplement in poultry feeding yielded results demonstrating the necessity of developing and theoretically substantiating optimal inclusion levels of this trace element in compound feeds for different species and technological groups of poultry, including meat-type ducklings.

It has now been established that the inclusion of selenium in compound feeds for young meat-type poultry alters the direction of physiological and biochemical processes in the body, improves nutrient digestibility and metabolism, and consequently enhances body weight, survivability, feed conversion efficiency, as well as the organoleptic properties, amino acid and mineral composition, and overall nutritional and biological value of meat (Sobolev et al., 2021; Hrynevych et al., 2023; Khabinets, 2025).

However, some aspects of the effects of selenium-containing supplements on the organism of young poultry, particularly their slaughter and meat qualities, remain insufficiently studied or have not been adequately reflected in the scientific literature. Due to the limited number of studies on the effect of selenium supplementation in compound feeds on the meat productivity of waterfowl, particularly ducklings, this research was undertaken.

The aim of this study was to investigate the effect of different levels of selenium supplementation in compound feeds on the slaughter and meat quality of young ducks.

2. Materials and methods

Experimental studies were conducted on ducklings of the Ukrainian White breed. For the scientific and production experiment, groups of one-day-old healthy ducklings were formed based on the principle of analogs, taking into account their live weight, origin, and physiological condition. The duration of the experiment corresponded to the technological rearing cycle of ducklings for meat production and lasted 56 days.

From day 1 to 56 of age, the ducklings were fed dry complete compound feeds balanced for major nutrients and biologically active substances in accordance with established standards (Bratishko et al., 2013) (Table 1).

Table 1
Formulations of complete compound feeds for ducklings reared for meat production

Components, %	Age of birds, weeks	
	1–3	4–8
Maize	44.0	15.6
Barley	11.0	9.0
Wheat	22.2	54.0
Sunflower meal	3.0	3.0
Meat and bone meal	5.0	5.0
Fish meal	7.7	2.32
Feed yeast	2.9	3.0
Sunflower oil	–	2.4
Lysine	0.18	0.8
Methionine	0.08	0.22
Monocalcium phosphate	0.55	1.08
Limestone	2.0	2.05
Sodium chloride	0.36	0.5
Vitamin premix	0.03	0.03
Mineral premix	1.0	1.0
Content per 100 g of compound feed:		
Metabolizable energy, kcal	287.0	290.1
Crude protein, g	18.0	16.0
Crude fiber, g	2.6	2.7
Calcium, g	1.4	1.3
Phosphorus, g	0.8	0.8
Sodium, g	0.3	0.3
Lysine, g	1.0	1.2
Methionine + cystine, g	0.7	0.7

Ducklings of the first (control) group did not receive selenium supplementation with compound feeds. Birds of the experimental groups were additionally supplemented with selenium according to the experimental design (Table 2).

Table 2
Experimental design

Group	Number of birds	Selenium supplementation in compound feed, mg/kg
1 (control)	100	Complete compound feed (CF)
2 (experimental)	100	CF + 0.2
3 (experimental)	100	CF + 0.4
4 (experimental)	100	CF + 0.6

Selenium was introduced into the compound feeds for ducklings as part of a mineral premix. Sodium selenite (Na_2SeO_3) was used as the selenium source, with a conversion coefficient of 2.20.

Ducklings were reared on deep litter with free access to feed and water, in compliance with technological standards for stocking density, microclimate, and lighting according to established guidelines (Galibarenko et al., 2005).

At the end of the experiment, 4 birds from each group (2 males and 2 females) were selected for slaughter evaluation and subjected to control slaughter according to standard procedures. The selected ducklings had a live weight corresponding to the average body weight of their respective group at the end of the rearing period. During slaughter, carcass appearance, as well as the condition of internal organs and tissues, were assessed. After slaughter, complete anatomical dissection and deboning of carcasses were performed in accordance with established recommendations.

Slaughter and meat quality of young ducks were evaluated using the following parameters:

– weight of semi-eviscerated carcass, g – carcasses from which the intestines with cloaca, filled crop, oviduct and ovary (in females) were removed;

– weight of eviscerated carcass, g – carcasses from which all internal organs, head (between the second and third cervical vertebrae), neck (without skin) at the level of the shoulder joints, and feet to the hock joint or slightly below (but not more than 20 mm) were removed;

– weight of edible parts, g – breast, leg and body muscles, liver without gallbladder, heart, gizzard without contents and cuticle, kidneys, lungs, skin with subcutaneous fat, and internal fat;

– weight of inedible parts, g – feet, head, bones of the trunk and limbs, wings up to the elbow joint, gastrointestinal tract, oviduct, ovary, testes, trachea, and larynx.

Indicators characterizing slaughter and meat quality of young ducks were determined on chilled carcasses obtained immediately after slaughter, with a temperature not exceeding 25 °C.

Meat (anatomical) indices of duck carcasses were calculated using the formulas of B.K. Hindze (Besulin et al., 2003):

– edible parts index = (weight of edible parts) / (weight of eviscerated carcass) × 100 %;

– carcass meatiness index = (muscle weight) / (weight of eviscerated carcass) × 100 %;

– breast meat index = (breast muscle weight) / (weight of eviscerated carcass) × 100 %;

– leg meat index = (leg muscle weight) / (weight of eviscerated carcass) × 100 %;

– skin with subcutaneous fat index = (weight of skin with fat) / (weight of eviscerated carcass) × 100 %;

– bone index = (bone weight) / (weight of eviscerated carcass) × 100 %.

Carcasses of young ducks were photographed on a measuring board divided into squares of 10 × 10 cm.

Statistical analysis of the obtained data was performed using Microsoft Excel 2010 (version 14). Differences between the control and experimental groups were evaluated using Student's t-test and were considered significant at: * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

3. Results and discussion

Numerous studies have demonstrated that the live weight of young poultry at slaughter age has a strong positive and significant correlation with most zootechnical parameters characterizing meat quality. This finding is also confirmed by our results. In particular, it was established that selenium supplementation in compound feeds for ducklings of the experimental groups during the rearing period had a positive effect not only on live weight but also on meat productivity (Table 3).

Thus, the average weight of semi-eviscerated carcasses of ducklings in the second experimental group was higher than that of their counterparts in the control group by 1.2 %, in the third group by 6.3 % ($P < 0.001$), and in the fourth group by 3.6 % ($P < 0.05$), amounting to 1738.3 g, 1826.5 g, and 1779.3 g, respectively.

The dressing percentage of birds in all groups was practically at the same level. It was found that in the control group it reached 81.7 %, while in the experimental groups it was 81.1 %, 81.5 %, and 81.3 %, respectively. The slight difference (0.2–0.6 %) can be explained by an increase in the weight of the intestines, as well as feathers, blood, and crop in birds of the experimental groups.

The weight of eviscerated carcasses in ducklings of the experimental groups was also higher, ranging from 1325.0 to 1380.0 g compared to 1293.5 g in the control group. However, statistically significant differences for this parameter were observed only in the third and fourth experimental groups, where ducklings exceeded the control by 6.7 % ($P < 0.01$) and 4.3 % ($P < 0.05$), respectively.

Ducklings of the experimental groups showed advantages in the weight of edible parts. Compared to the control, the increase was 6.1 % ($P < 0.001$) in the second group, 10.7 % ($P < 0.01$) in the third, and 5.8 % ($P < 0.05$) in the fourth group. The increase in the relative weight of edible parts in the second group was mainly due to more intensive growth of muscle tissue, in the third group due to both muscle tissue and skin with subcutaneous fat, and in the fourth group primarily due to skin with subcutaneous fat (which is undesirable). This indicates that with increasing selenium levels in compound feeds, the proportion of muscle tissue in carcasses tended to decrease, while the proportion of skin with subcutaneous fat increased.

In addition, in ducklings of the third and fourth experimental groups, the proportion of edible viscera (liver, heart, and gizzard) slightly increased (by 0.1–0.2 %) compared to the control group (6.3 %).

The yield of edible parts is largely determined by the proportion of muscles, which form the basis of the carcass. Muscle tissue was more developed in ducklings of the second and third experimental groups, where total muscle yield reached 26.9 % and 25.3 %, respectively, compared to 24.7 % in the control and 23.8 % in the fourth group. The proportion of the most valuable part of the carcass—breast muscles—was higher in the third and fourth groups by 0.2% and 0.4 %, respectively, compared to the control (6.6 %). The highest yield of leg muscles (7.6 %) was also recorded in these groups, while the lowest value (7.4 %) was observed in the second experimental group. The control group occupied an intermediate position (7.5 %).

Table 3

Results of control slaughter, anatomical dissection, and deboning of duckling carcasses (% of pre-slaughter weight, $\overline{X} \pm S_{\overline{X}}$, n = 4)

Indicator	Group			
	1 (control)	2 (experimental)	3 (experimental)	4 (experimental)
Pre-slaughter weight, g	2102,5 ± 15,18	2142,5 ± 19,08	2240,0 ± 18,26*	2187,5 ± 17,24
%	100	100	100	100
Semi-eviscerated carcass, g	1717,3 ± 7,69	1738,3 ± 23,70	1826,5 ± 15,15***	1779,3 ± 16,22*
%	81,7	81,1	81,5	81,3
Eviscerated carcass, g	1293,5 ± 8,90	1325,0 ± 13,93	1380,0 ± 11,50**	1349,0 ± 15,22*
%	61,5	61,8	61,6	61,7
Total edible parts, g	1048,7 ± 6,17	1113,0 ± 5,87***	1161,0 ± 22,78**	1109 ± 17,62*
%	49,9	51,9	51,8	50,7
Edible viscera, g	133,5 ± 4,36	131,3 ± 4,01	144,8 ± 2,51	140,0 ± 2,45
%	6,3	6,1	6,5	6,4
Total muscles, g	519,0 ± 22,04	575,8 ± 32,82	566,8 ± 16,8	520,2 ± 16,24
%	24,7	26,9	25,3	23,8
Breast muscles, g	138,5 ± 5,47	135,3 ± 3,03	151,3 ± 5,42	152,8 ± 3,98
%	6,6	6,3	6,8	7,0
Leg muscles, g	158,5 ± 4,26	159,3 ± 4,41	171,3 ± 4,04	165,3 ± 5,82
%	7,5	7,4	7,6	7,6
Skin with subcutaneous fat, g	396,2 ± 31,63	406,0 ± 34,43	449,5 ± 18,24	448,8 ± 14,16
%	18,8	18,9	20,1	20,5
Total inedible parts, g	955,0 ± 12,73	936,0 ± 16,87	977,8 ± 16,99	980,7 ± 17,45
%	45,4	43,7	43,7	44,8
Feathers, blood, crop, g	223,7 ± 4,33	232,5 ± 11,9	235,0 ± 7,45	235,0 ± 5,77
%	10,6	10,9	10,5	10,8
Intestines, g	161,5 ± 7,06	171,7 ± 3,87	178,5 ± 3,42	173,2 ± 2,72
%	7,7	8,0	8,0	7,9
Head and legs, g	166,3 ± 3,10	162,3 ± 4,20	175,8 ± 2,33*	168,7 ± 4,36
%	7,9	7,6	7,8	7,7
Inedible viscera, g	25,3 ± 0,99	26,2 ± 1,66	24,7 ± 1,79	23,8 ± 1,19
%	1,2	1,2	1,1	1,1
Bones, g	378,3 ± 7,19	343,2 ± 14,39	363,7 ± 12,31	380,0 ± 5,60
%	18,0	16,0	16,2	17,3
Ratio (inedible : edible)	1 : 1,10	1 : 1,19	1 : 1,19	1 : 1,13
Ratio (bones : muscles)	1 : 1,37	1 : 1,67	1 : 1,56	1 : 1,37

Note: Edible and inedible parts do not include neck muscles and bones, which account for approximately 4.4–4.7 %

Regarding inedible parts, their proportion in ducklings of the second and third experimental groups was 43.7 %, and in the fourth group 44.8 %, which is 1.7 % and 0.6 % lower, respectively, than in the control group. The decrease in inedible parts was mainly associated with a reduction in the relative weight of bones by 0.7–2.0 % in the experimental groups.

The ratio of inedible to edible parts was higher by 2.7–8.2 % in ducklings of the experimental groups compared to the control, reaching 1:1.19 in the second and third groups and 1:1.13 in the fourth group.

Furthermore, birds of the second and third experimental groups were superior to their counterparts in the control and fourth groups in terms of the bone-to-muscle ratio (1:1.67 and 1:1.56 vs. 1:1.37, respectively).

Changes in meat conformation and fatness of birds in the experimental groups were also confirmed by Figures 1–4. Ducklings of the experimental groups generally exhibited well-developed musculature. The keel bone was firm and not prominent. Subcutaneous fat deposition was observed in the breast and abdominal areas.

In the control group, musculature was developed satisfactorily, although the keel bone was not prominent. The keel bone remained unossified. Slight subcutaneous fat deposits were observed in the breast and abdominal regions.

All carcasses had a characteristic odor typical of fresh poultry meat.

During anatomical dissection and deboning of carcasses, no pathological changes in organs and tissues or deviations from the control were observed in ducklings of the experimental groups.

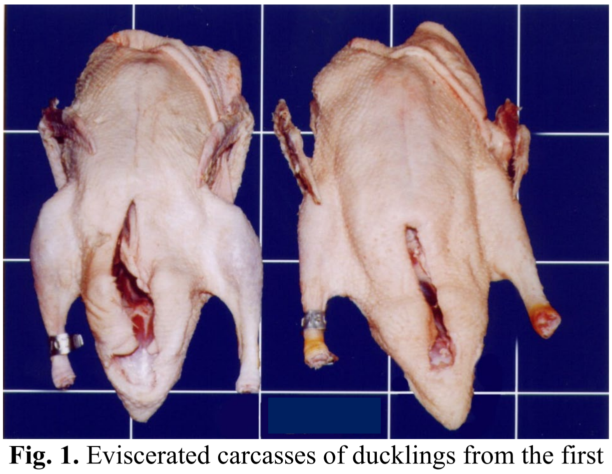

Fig. 1. Eviscerated carcasses of ducklings from the first (control) group

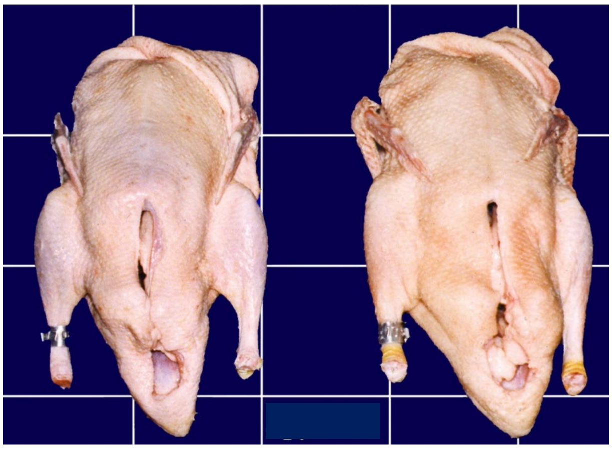

Fig. 2. Eviscerated carcasses of ducklings from the second experimental group

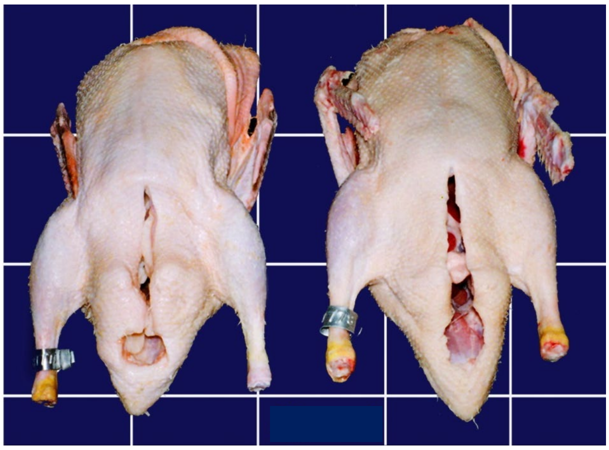

Fig. 3. Eviscerated carcasses of ducklings from the third experimental group

Fig. 4. Eviscerated carcasses of ducklings from the fourth experimental group

In order to provide a comprehensive evaluation of the meat quality of ducklings reared on compound feeds with different selenium levels, meat indices were calculated (Table 4).

Analysis of the anatomical and morphological composition of carcasses revealed certain differences between the groups, which, in our opinion, are due to the indirect effects of different selenium levels on the organism of ducklings reared for meat production. It was established that the edible parts index in ducklings of the experimental groups (2–4) was higher than in the control group by 3.34 %, 2.89 %, and 1.08 %, respectively. The increase in the yield of edible parts was associated with an increase in the skin with subcutaneous fat index (by 0.01–2.64 %) and a decrease in the bone index (by 1.08–3.35 %).

Table 4
Meat indices of duckling carcasses, % ($\overline{X} \pm S_{\overline{X}}$, n = 4)

Index	Group			
	1 (control)	2 (experimental)	3 (experimental)	4 (experimental)
Edible parts index	70.75	74.09	73.64	71.83
Carcass meatiness index	40.12	43.45	41.07	38.56
Breast meat index	10.70	10.21	10.96	11.33
Leg meat index	12.25	12.02	12.41	12.25
Skin with subcutaneous fat index	30.63	30.64	32.57	33.27
Bone index	29.25	25.90	26.35	28.17

Birds of the experimental groups (except for the fourth group) showed better carcass muscling. Breast and leg meatiness were higher in ducklings of the third and fourth experimental groups compared to those of the control and second groups, as indicated by the corresponding indices.

Due to the limited number of literature data on the effect of different selenium supplementation levels in compound feeds on the slaughter and meat qualities of ducklings, a full comparison of our results is not possible. According to some studies, supplementation of selenium at a dose of 0.4 mg/kg in the form of selenium-enriched yeast in diets of Muscovy ducklings increased dressing percentage by 4.9 %, eviscerated carcass weight by 28.3 %, and the proportion of edible viscera (heart, liver, and gizzard) by 0.84 %. When selenium was used in the form of selenomethionine, the corresponding increases were 4.3 %, 18.7 %, and 0.54 %, compared to the control group reared on a selenium-deficient diet (Hussein et al., 2024).

According to other data, supplementation of selenium at 0.4 mg/kg in compound feeds for ducklings (Cherry Valley hybrid) in the form of the organic preparation ALKOSEL® R397 did not increase dressing percentage but contributed to a higher proportion of skin with subcutaneous fat in cuts, particularly in the breast and thighs (Baltic et al., 2017).

Overall, our findings do not contradict the results reported by Egyptian and Serbian researchers, although some differences were observed. These discrepancies are likely due to differences in feed composition, breed, age and sex of ducklings, as well as the form of selenium used (organic or inorganic).

4. Conclusions

Supplementation of compound feeds for ducklings with selenium at the studied levels had a positive effect on their slaughter and meat quality, in particular by increasing carcass weight, the yield of edible parts, and reducing the proportion of bones. The best meat quality indicators were observed in ducklings whose diets were supplemented with selenium at a level of 0.4 mg/kg.

Conflict of interest

The authors declare no conflict of interest.

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