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Influence of Organic Selenium Application in Concentrate Mixtures on the Increase of Ducks in Fattening

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Abstract
Poultry meat, including duck meat, has a high nutritional value (over 20% protein and less than 5% fat in the meat of breasts and drumsticks with carb). These data refer to hybrid duck lines intended for fattening. Modern production of duck meat implies intensive fattening in a period of 49 days with the correct selection of hybrids, arrangement and control of zoohygienic and microclimatic conditions in facilities and the use of optimized feed mixtures. Taking into account the interest of consumers, it is very important that fattened ducklings have good yields and favorable carcass conformation, which is influenced by: hybrid, sex, age, health, diet, live weight, length of fattening and conditions and ways of keeping ducklings in fattening. Today, it is a well-known fact in the world that animal nutrition can affect the nutritional value of meat, milk, eggs, and that it is one of the ways to get food with special properties known as functional food. Selenium-enriched foods can also be considered functional foods.

I. INTRODUCTION

The genotypes Pekin, Muscovy and several hybrid lines are most often used for the production of duck meat, the most famous of which is the Cherry Valley hybrid. It is understood that in different countries of Asia there are several indigenous genotypes of ducks that are bred primarily for meat production, but there are also genotypes for egg production. Different production systems are used in duck breeding.

In developed countries, fattening ducks are mostly reared in closed intensive systems, without access to pasture and water, except for drinking water. Organic production is used less frequently. In Asia, most duck production is extensive and related to water bodies (ponds) and even rice fields (Adeola, 2006; MahmutovićHava, 2014; Baeza, 1995; Scott and Dean, 1999).

Intensive duck breeding systems require, in addition to appropriate housing conditions, that animals be provided with all the necessary ingredients that enable the full use of their genetic potential. One of the most widespread duck breeds in the world is the Peking duck, and duck meat production is mainly based on commercial crosses of different Pekingese species (Anasplatyrynchos) (Pingel, 1997; Zejidler, 1998). It originated in China, from where it spread to Europe and America. The most famous is the American and German strains, both white in color. Males reach a weight of about 4-6 kg, and females 3-4 kg.

Nutrition is also an important factor influencing carcass yield. Poultry nutrition is based primarily on knowing the needs and providing adequate food in order to achieve optimal production results and obtain a satisfactory amount of high-value foods of animal origin for human consumption, as well as the appropriate choice of nutrients (Ševković et al., 1991; Hayes et al., 1979; He et al., 2003; Underwood and Suttle, 1999; US / NAS, 1980; NRC, 1980, 1994).

Selenium is an essential element for the functioning of the human and animal body. It is part of the enzymes glutathione peroxidase and iodothyroninedeiodinase. Selenium has a role in the system of protection of biological membranes from oxidative damage. This role is performed together with vitamin E. Of the total selenium in the body, 40% is present as an active ingredient in the enzyme glutathione percosidase (GPx). Selenium, together with vitamin E, has the role of antioxidant, and participates in the conversion of free radicals into inactive and less toxic compounds.

Disorders related to selenium deficiency occur in all animals, and the occurrence, character and intensity of the disorder depend on the type of animal. Zenker degeneration of skeletal muscles and heart muscle and muscular dystrophy are the most common. In Zenker degeneration, muscle tissue is replaced by connective tissue in the form of white stripes in muscle fibers.

Selenium deficiency causes atrophy of the pancreas with a reduction in the secretion of lipase, trypsinogen, chymotrypsinogen, nutritional pancreatic atrophy, resulting in significantly lower growth, poor feathering, etc. (Schubert et al., 1961).

The most famous and most used hybrid is Cherry Valley, originally from England, whose fattened ducklings reach a final body weight of about 3 kg in 7 weeks. Kralik et al. (2008) state that in intensive fattening young hybrid ducks reach a body weight of 3.00 to 3.50 kg at the age of 7 weeks.

Bašić (2008) states that ducks fatten up to 3.2 kg on average in 7 weeks of fattening, with food consumption of 8 kg and conversion on average of 2.6 to 2.7 kg of food. Technological mortality is up to 5%, and the slaughter yield ranges from 72 to 73%.

Janječić et al. (2005) investigated the performance of Cherry Valley fattening ducks at the age of 49 days. Ducklings were divided into three groups (A, B and C) and fed on three different types of mixtures. Group A achieved an average body weight of 3298.6 g, group B of 3118.5 g, and group C of 3247.0 g.

II. MATERIAL AND METHODS

The research of the influence of organic selenium on the production results of fattening ducks, carcass meat parameters, meat quality and selenium content in the meat and internal organs of fattened ducklings was conducted on a total of 240 one - day - old ducklings. Ducklings were randomly divided into 4 experimental groups (K0, K1, K2 and K3). There were 60 one-day-old ducklings in each experimental group, and fattening was performed in three repetitions of 20 ducklings. The research plan is shown in Table 1.

Table 1. Research plan

	Experimental groups			
	K0	K1	K2	K3
	Number of ducklings			
According to repetitions				
I - V1	20	20	20	20
II - V2	20	20	20	20
III- V3	20	20	20	20
Total	60	60	60	60

Duckling diet

Ducklings are in two phases of feeding duration in fattening, fed with two and nutritionally different concentrate feed mixtures: starter (from 1st to 14th day) and finisher (from 15th to 49th day of fattening).

The first, the control group of ducks (K0) during fattening received food without added selenium in both phases of fattening.
The second group of ducks (K1) was fed with food in both phases of fattening as the control group, but with the addition of 0.2 mg / kg of organic selenium (commercial preparation, Alcosel R 397, France).
The third group of ducks (K2) used food with 0.4 mg / kg of organic selenium in fattening, and the fourth group of ducks (K3) with 0.6 mg / kg of organic selenium.
The experiment lasted 7 weeks (49 days), and the food recipe for each phase of fattening was adjusted to the selected hybrid duck.
During fattening, each week and at the end of fattening, each individual was weighed individually and for each of these periods, ie for total fattening, growth, consumption and conversion of food were calculated.
The raw material compositions of the mixtures used in duck fattening (starter and finisher) are shown in Tables 2 and 3.

Table 2. Raw material composition of concentrate mixture starter for fattening ducklings

Raw material (%)	Starter concentrate mixture (1st to 15th day)			
	Experimental groups			
	K0	K1	K2	K3
Corn	54,83	54,63	54,43	54,23
Soybean semolina	18,00	18,00	18,00	18,00
Soybean meal	16,00	16,00	16,00	16,00
Soy protein concentrate	5,00	5,00	5,00	5,00
Alcoholic yeast	2,50	2,50	2,50	2,50
Mono-Ca-phosphate	1,30	1,30	1,30	1,30
Premix for fattening ducks	1,00	1,00	1,00	1,00
Livestock chalk	0,90	0,90	0,90	0,90
They are cattle	0,35	0,35	0,35	0,35
Dl-Methionin	0,12	0,12	0,12	0,12
Organic selenium (Se)	-	0,20	0,40	0,60
Σ	100,00	100,00	100,00	100,00

Table 3 Raw material composition of duck fattening concentrate mixture

Raw material (%)	Finisher concentrate mixture (days 15 to 49)			
	Experimental groups			
	K0	K1	K2	K3
Corn	72,02	71,82	71,62	71,42
Soybean meal	11,00	11,00	11,00	11,00
Soybean semolina	9,00	9,00	9,00	9,00
Alcoholic yeast	2,50	2,50	2,50	2,50
Soy protein concentrate	2,00	2,00	2,00	2,00
Mono-Ca-phosphate	1,20	1,20	1,20	1,20
Premix for fattening ducks II	1,00	1,00	1,00	1,00
Livestock chalk	0,90	0,90	0,90	0,90
They are cattle	0,30	0,30	0,30	0,30
Dl-Methiomin	0,08	0,08	0,08	0,08
Organic selenium (Se)	-	0,20	0,40	0,60
Σ	100,00	100,00	100,00	100,00

The calculated chemical composition of the mixtures used in duck fattening is shown in Tables 4 and 5.

Table 4. Calculative chemical composition of starter fattening concentrate mixture

Name	Unit of measure	Starter concentrate mixture (1st to 15th day)			
		Experimental groups			
		K0	K1	K2	K3
Dry matter	%	88,06	88,07	88,08	88,08
Crude protein	%	22,16	22,16	22,13	22,10
Crude fat	%	5,73	5,72	5,72	5,71
Crude fiber	%	3,34	3,34	3,33	3,33
Ca	%	0,65	0,63	0,63	0,63
Na	%	0,14	0,14	0,14	0,14
Cl	%	0,20	0,20	0,20	0,20
P	%	0,75	0,75	0,75	0,75
Lysine	%	1,41	1,41	1,41	1,41
Methionine	%	0,51	0,51	0,51	0,51
A	IJ/kg	10,00	10,00	10,00	10,00
D3	IJ/kg	2,00	2,00	2,00	2,00
E	mg/kg	30,00	30,00	30,00	30,00
ME poultry	MJ/kg	13,19	13,16	13,13	13,10

Table 5. Calculative chemical composition of duck fattening concentrate concentrate mixture

Name	Unit of measure	Finisher concentrate mixture (days 15 to 49)			
		Experimental groups			
		K0	K1	K2	K3
Dry matter	%	87,31	87,32	87,32	87,33
Crude protein	%	16,09	16,08	16,08	16,05
Crude fat	%	4,52	4,51	4,51	4,50
Crude fiber	%	2,87	2,87	2,86	2,88
Ca	%	0,58	0,58	0,58	0,58
Na	%	0,12	0,12	0,12	0,12
Cl	%	0,17	0,17	0,17	0,17
P	%	0,67	0,67	0,67	0,67
Lysine	%	0,96	0,96	0,96	0,96
Methionine	%	0,41	0,41	0,41	0,41
A	IJ/kg	10,00	10,00	10,00	10,00
D3	IJ/kg	2,00	2,00	2,00	2,00
E	mg/kg	30,00	30,00	30,00	30,00
ME poultry	MJ/kg	13,38	13,35	13,32	13,28

Control measurements of experimental units were performed during the migration of one-day-old ducklings, then on the 7th, 14th, 21st, 28th; 35th; On the 42nd and 49th day, respectively, at the end of fattening. Measurements were performed on an electronic scale with an accuracy of ± 1 g. Based on the measurement results, the average body weight of the ducklings was calculated at the end of each phase, as well as at the beginning and end of the experiment collectively. From the differences in body weight at the beginning and end of each week of the respective phase of fattening, the total gain was calculated, and based on the duration of individual phases, as well as the experiment itself, the total and daily gain of ducklings in fattening.

Growth control

During the research period, ducklings were weighed every week according to experimental groups and repetitions. Body weights were monitored on days 1, 7, 14, 21, 28, 35, 42, and 49. Weighing was performed using an electronic scale Libelaelsi BV-P 3828 with a deviation of ± 5 g, to determine the weekly increase in body weight. Immediately on the day of moving in on the 1st day of fattening, in each experimental group the ducklings were marked by putting rings on their feet, with numbers from 1-240 according to the experimental groups (K0 = 1-60, K1 = 61-120, K2 = 121-180 and K3 = 181-240). At the end of fattening, after the last weighing on the farm, the ducks were placed in marked plastic transport cages according to the experimental groups for each repetition.

Fattened ducklings that did not reach the minimum body weight of 1800 g (scrap ducklings) were separated from the experiment. After marking the transport cages and loading into the vehicle, the fattened ducklings were transported to slaughter according to the dynamics of moving in (repetitions).

III. RESEARCH RESULTS

Results of duck growth in fattening

The total growth of ducks in fattening by weeks of fattening is shown in Table 6.

Table 6. Total growth of ducks in fattening by weeks of fattening and groups (kg)

Fattening period (days)	Group			
	K0	K1	K2	K3
1-7	10,20	10,35	9,57	9,95
7-14	29,24	29,90	30,37	28,44
14-21	33,70	34,64	32,42	31,16
21-28	36,27	37,04	35,64	35,01
28-35	40,15	42,50	40,24	33,60
35-42	36,05	29,72	37,96	34,97
42-49	21,85	24,18	30,26	29,22

The increment of ducks in fattening from the 1st to the 14th day, the 14th to the 49th day, as well as the increment for the total fattening period is shown in Table 7.

Table 7. Total growth of ducks by fattening periods (kg)

Fattening period (days)	Group			
	K0	K1	K2	K3
1-14	39,43	40,25	39,94	38,40
14-49	168,02	168,08	176,52	163,96
1-49	207,45	208,23	216,46	202,36

The daily gain of ducks by weeks of fattening and experimental groups is shown in Table 8.

Table 8. Daily gain of ducks by seven-day period in fattening (g)

Fattening period (days)	Group			
	K0	K1	K2	K3
1-7	24,28	24,64	22,79	23,70
7-14	69,61	71,20	72,32	67,73
14-21	80,24	82,48	77,19	74,19
21-28	86,36	88,19	86,30	83,36
28-35	95,60	101,19	97,43	81,36
35-42	85,83	70,76	91,91	86,13
42-49	52,91	58,55	73,27	71,97

The daily gain of ducks from the 1st to the 14th day, from the 14th to the 49th day and for the total fattening period, is shown in Table 9.

Table 9. Daily growth of ducks by fattening periods (g)

Fattening period (days)	Group			
	K0	K1	K2	K3
1-14	46,95	47,92	47,92	45,71
14-49	81,37	81,39	85,48	79,40
1-49	71,76	72,03	74,88	70,00

Duck body weight during the experiment

The body weight of ducks was measured every seven days, and the calculated average weights of ducks are shown in Tables 10 and 11. The average body weights of ducks up to the 14th day of fattening (starter diet) are shown in Table 10.

Table 10. Average body weight of ducks from the 1st to the 14th day of fattening (g)

Group	Days experiments ($\overline{X}$ ±Sd)		
	1	7	14
K0	56,42±3,50	226,4±20,68	713,7±81,22
K1	57,43±4,10	229,9[a]±25,32	728,3[a]±92,01
K2	56,58±3,81	216,1[a]±27,25	722,3±113,40
K3	56,00±3,78	221,9±29,42	696,0[a]±120,20

Legend: same letter [a] – $p<0,05$

Table 11. Average body weight of ducks from the 21st day to the end of fattening (g)

Group	Number of ducks and days of experimentation ($\overline{X}$ ±Sd)									
	n	21.	n	28.	n	35.	n	42.	n	49.
K0	60	1275±187,6	60	1880±286,4	60	2549±411,2	60	3150±472,3	56	3659[a]±395,4
K1	60	1306[a]±201,3	60	1923±308,3	60	2631[a]±371,4	58	3181±462,4	55	3741±360,0
K2	59	1284±218,5	59	1888±303,9	59	2570±401,5	59	3214±472,4	56	3856[a,b]±389,6
K3	6	1207[a]±216,8	5	1829±287,9	5	2440[a]±384,3	5	3043±443,0	5	3636[b]±384,6

	0		9		8		8		5	

Legend: same letter [a] – p<0,05

IV. DISCUSSION OF RESULTS

Discussion of duck growth in fattening

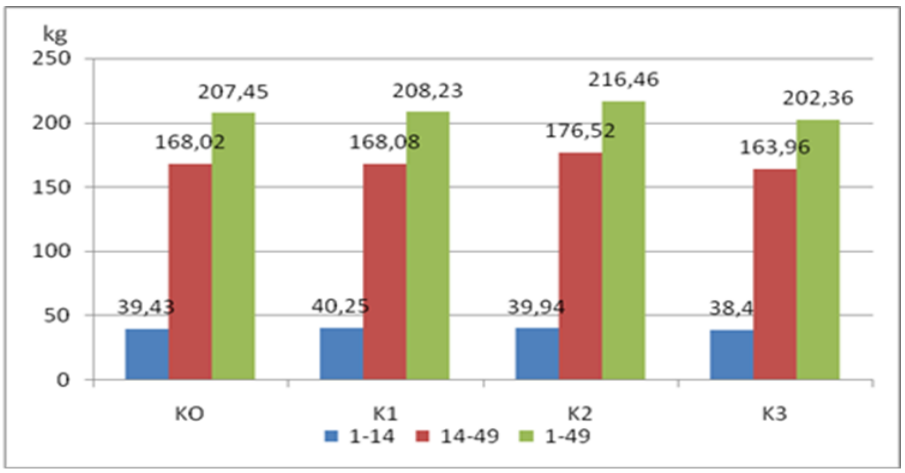
In the first period of fattening (from 1-14 days), the highest total increase was found in the K1 group (40.25 kg), and the lowest in the K3 group (38.40 kg). In the second fattening period, the highest total gain was found in K2 group ducks (176.52 kg) and the lowest in K3 group (163.96 kg). For the total fattening period, the highest increase was also found in the K2 group (216.46 kg), and the lowest in the K3 group (202.36 kg) (Chart 1). For the total fattening period, the daily gain was also the highest in the K2 group 74.88 kg, and the lowest in the K3 group (70.00 kg) (Chart 2).

In the control K0 and experimental K1 and K2 groups, the total increase up to the 35th day increased, after which it decreased in the last two weeks. In the K3 group, a decrease in growth was recorded in the last week of fattening.

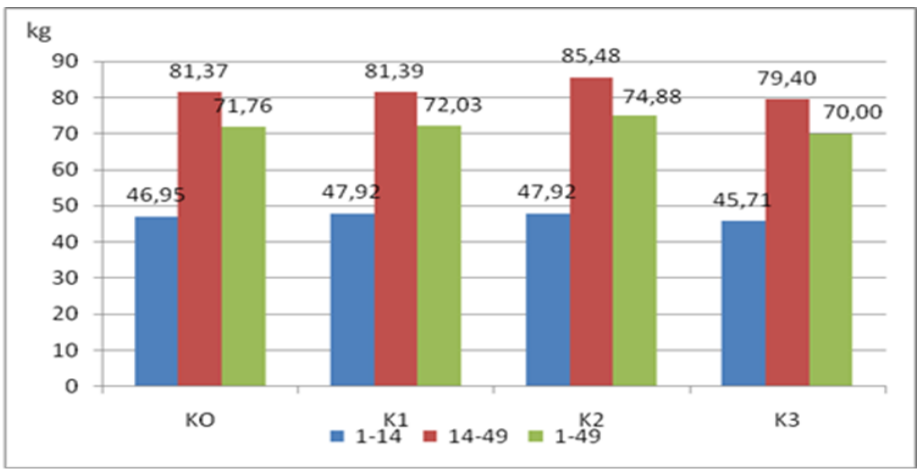
For the total period of fattening, the largest increase was determined in the experimental group K2, followed by K1, control group K0 and experimental group K3.

In the control group K0, experimental groups K1 and K2, the daily gain increased until the 35th day, and in the K3 group until the 42nd day.

For the total fattening period, the highest daily gain was recorded in the K2 group (74.88 g), and the lowest in the K3 group (70.00 g).



Graph 1. Total growth of ducks by fattening periods



Graph 2. Daily growth of ducks by periods of fattening

The daily gain of Canendis R31, R41, R51, R61 ducks in fourteen days of fattening was between 17.7 g and 21.6 g, depending on the hybrid. The daily gain of females from the second to the fifth week was between 52.85 g and 58.09 g, and the male gain of 64.82 g to 85.71 g. From the fifth to the ninth week of fattening, the gain in females was between 80 , 36 g and 82.14 g, and in males 128.57 g to 141.43 g (Ristić and Klein, 1989).

There are no data in the literature on the influence of different amounts of selenium added in food on food consumption and growth of ducks in fattening. These data are the most common when it comes to poultry when it comes to the influence of selenium on the production results of broilers (fattening chickens). Most authors agree that better production results are achieved by using organic selenium in relation to the use of inorganic selenium in broiler diet (MarkovicRadmila, 2007, Yang et al., 2012; Arruda et al., 2004; Anciuti et al. , 2004; Edens and Gowdy, 2004). Data on the influence of different amounts of organic selenium in broiler diet indicate that even with larger amounts of added organic selenium, no significant negative effects on broiler production results in fattening were observed, but an increase in selenium content in meat was found. However, based on the results of Jokić et al. (2005), Drljačić (2013), Moksenes (1983) the best production results of broilers in fattening are achieved when using 6 mg / kg of selenium in the mixture. Although larger amounts of selenium do not have significant negative effects on production results, they can affect the economics of production as they make it more expensive.

Discussion of body fat gain

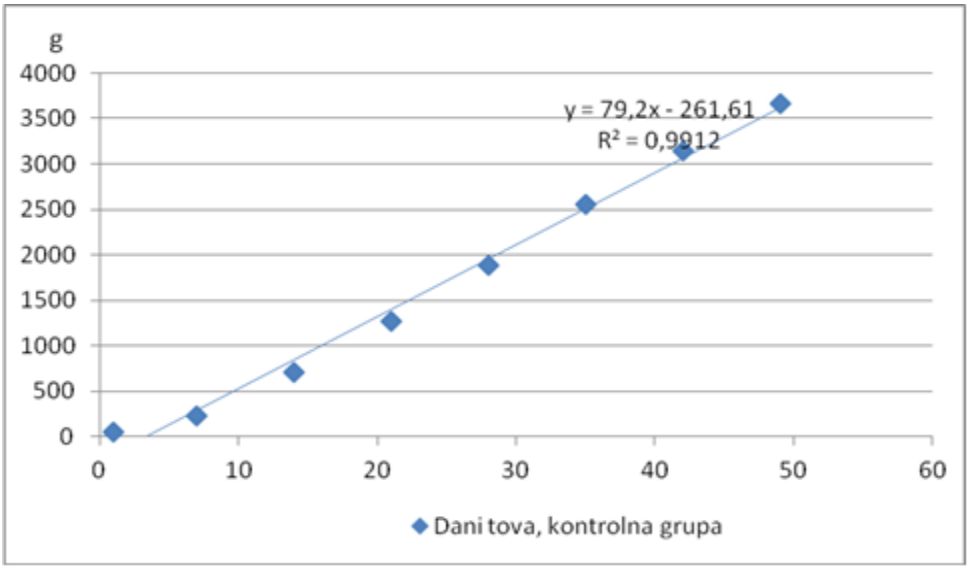
At the beginning of the experiment, no statistically significant difference was found between the formed groups of ducks, and the average weights ranged from 56.00 ± 3.78 g (K3 group) to 57.43 ± 4.10 g (K1 group). On the seventh day of the experiment, the average body weight of ducks ranged from 216.1 ± 27.25 g (K2 group) to 229.9 ± 25.32 g (K1 group). A statistically significant difference ($p < 0.05$) between duck body weights was found only between the K1 and K2 groups. The average weight of ducks on the 14th day of the experiment was from 696.0 ± 120.20 g (K3 group) to 728.3 ± 92.01 g (K1 group). A statistically significant difference ($p < 0.05$) between the average body weights on day 14 was found between the K1 and K3 groups of ducks (Table 11).

The average body weight of ducks on the 21st day of the experiment was from 1207 ± 216.8 g (K3 group) to 1306 ± 201.3 g (K1 group). A statistically significant difference ($p < 0.05$) between the average body weights on the 21st day of the experiment was found between the K1 and K3 groups of ducks. No statistically significant difference was found between the average duck weights on day 28 of fattening, and the average weights ranged from 1829 ± 287.9 g (K3 group) to 1923 ± 308.3 g (K1 group). On the 35th day of fattening, the average weight of ducks was from 2440 ± 384.3 g (K3 group) to 2631 ± 371.4 g (K1 group). A statistically significant difference ($p < 0.05$) was found between the average body weights of the K1 and K3 groups. On the forty-second day of the experiment, no statistically significant difference was found between the average masses of the compared groups of ducks. The average weights on the 42nd day of the experiment ranged from 3043 ± 443.0 g (K3 group) to 3214 ± 472.4 g (K2 group) (Table 12).

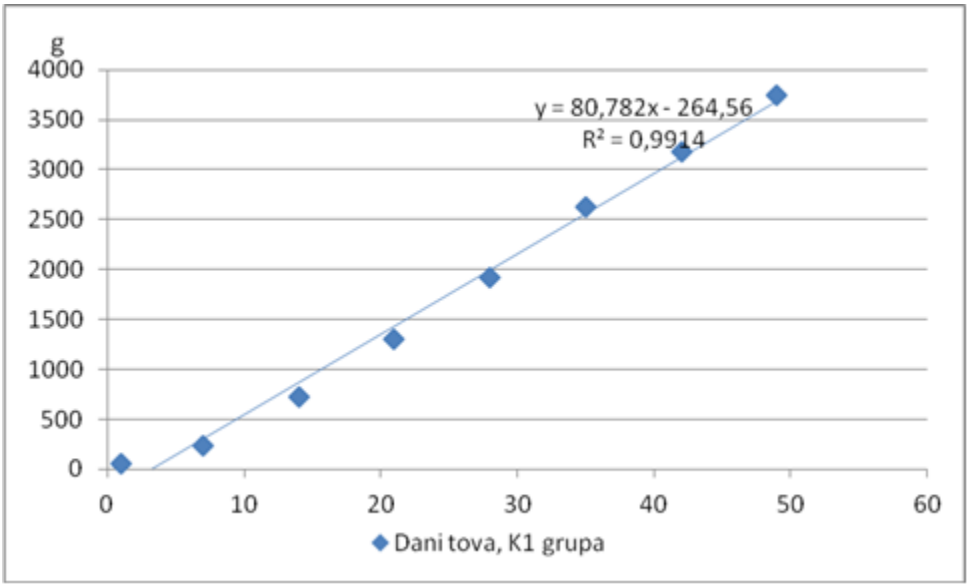
The average body weight of ducks on the farm (day 49, end of the experiment) of group K2 (3856 ± 389.6 g) was statistically significantly higher ($p < 0.05$) than the average weight of ducks of control group K0 (3659 ± 395.4 g)) and the average weight of K3 group ducks (3636 ± 384.6 g). In other cases, comparisons of the average body weight of ducks on the farm did not differ statistically significantly. As on the farm, so at the slaughterhouse, the average weight of ducks of group K2 (3810 ± 393.7 g) was statistically significantly higher ($p < 0.05$) than the average weight of ducks of control group K0 (3613 ± 402.8 g), or K3 groups (3588 ± 392.0 g) (Table 13).

Changes in body weight of control and experimental ducks during fattening were shown in Charts 3 - 6. The average weight of ducks on the first day of the experiment was from 56.00 g to 57.43 g and the average weight of ducks at the beginning of the experiment did not differ statistically significantly. After only seven days, the duck weight increased to 216.1 g (K2 group) to 229.9 g (K1 group). From days 14 to 35, duck masses had the following descending sequence of K1> K2> K0> K3 groups. However, the relationships on days 42 and 49 change significantly. Namely, on the 42nd and 49th day the ducks of group K2 had the highest weight (0.4 mg / kg of selenium in food) followed by ducks of group K1 (0.2 mg / kg of selenium in food), ducks of control group (without added selenium) , while K3 group ducks had the lowest weight (0.6 mg / kg of selenium in the mixture was added to the food).

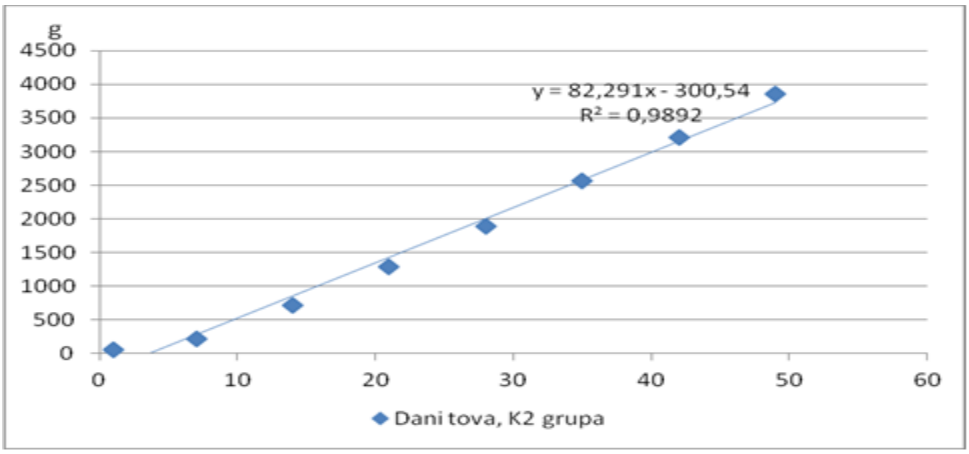
At the end of the experiment, the duck weights ranged from 3636.0 g (K3 group) to 3856.0 g (K2 group). When the mass of the control group of ducks after seven-day periods is indexed with 100, it is noticeable that the masses of ducks of K1 group are the total fattening period above the indexed mass of the control group of ducks, and K2 group of 21 days of fattening. This group had the highest average weight at the end of fattening. In the K3 group of ducks, the average weight was lower than the indexed weight of the control group of ducks. In the end, the weight of this group of ducks was close to the average weight of ducks of the control group.



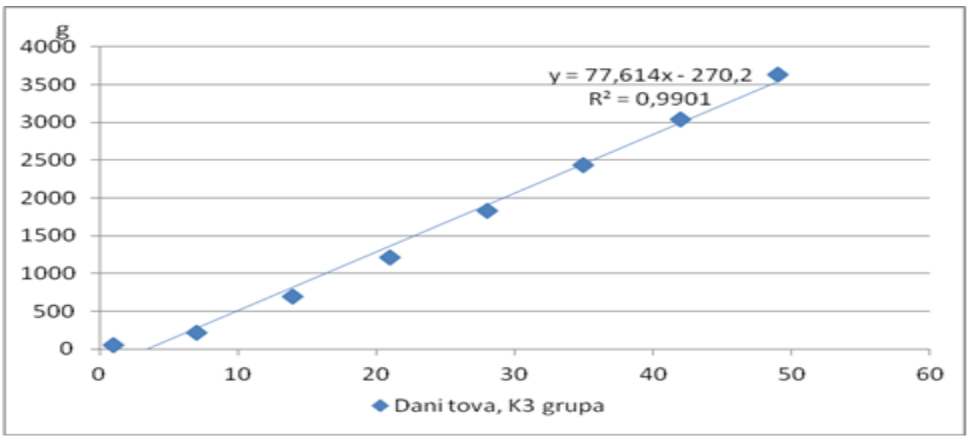
Graph 3. Change in body weight of control group ducks during fattening



Grafikon 4.Promjenatjelesnemasepataka K1 grupe u tokutova

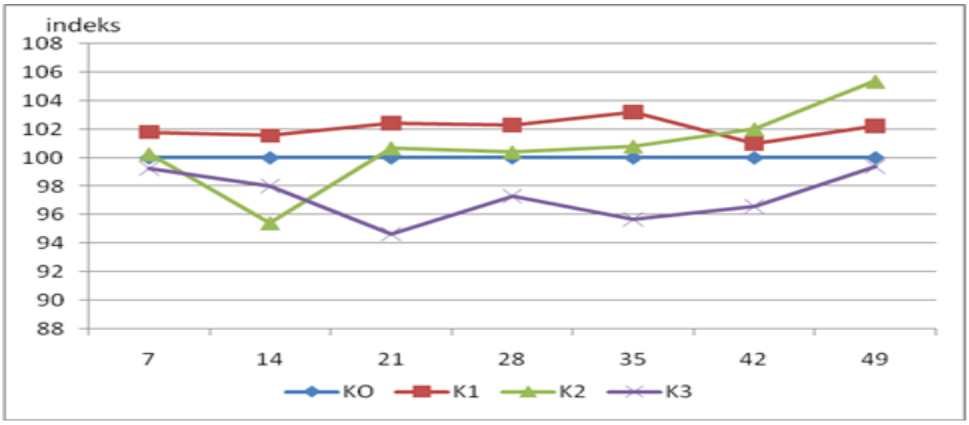


Graph 5. Change in body weight of K2 group ducks during fattening



Graph 6. Change in body weight of K3 group ducks during fattening

The indexed mass of ducks during the experiment is shown in Graph 7. The masses of the control group of ducks K0 obtained every seven days were indexed with 100. The average body weights of K1 and K2 of ducks were (with the exception of K2 of ducks 14 days) above the average weight of ducks K0. At the end of the experiment, the average weight of K3 group ducks was close to the average weight of K0 control group ducks.



Graph 7. Indexed average body weight of ducks during the experiment

V. CONCLUSION

The best total gain for the total fattening period was in the K2 group (216.46 kg), followed by the K1 group (208.23 kg), the K0 group (207.45 kg) and the K3 group (202.36 kg). The daily gain of ducks in fattening from the 1st to the 49th day was 74.88 g in K2 group, 72.03 g in K1 group, 71.76 g in K0 group and 70.00 g in K3 group.

Statistically significantly higher average body weight at the end of fattening, ie before slaughter, had K2 group (3856 g, 3810 g, individually) compared to the average body weight of ducks on the farm and before slaughter K0 group (4659 g, 3613 g, individually) and K3 groups (3636 g, 3588 g, individually).

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