Animal Science Papers and Reports vol. 34 (2016) no. 2, 181-194
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Effect of dietary selenium and vitamin E on chemical and fatty acid composition of goose meat and liver*

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(Accepted March 30, 2016)

The effect of dietary supplementation with organic selenium and vitamin E on chemical characteristics and fatty acid composition of goose meat (breast and leg muscles) and liver is described. Two-hundred one-day-old White Koluda® goslings were randomly divided into two groups balanced by sex, with five replicates each. Up to week 13 of age the control group was fed basic feeds, while the experimental group was fed the basic feeds supplemented with 0.3 mg/kg organic selenium (Se) and 100 mg/kg vitamin E (Vit. E). For the fattening-finishing phase during weeks 14-16 both groups were fed identically with oat grain and ground cereals. Feed supplementation with 0.3 mg/kg Se and 100 mg/kg Vit. E resulted in the production of goose meat and liver with significantly higher selenium contents, 1.88-2.25-fold higher in meat and 1.68-fold greater in the liver. Other chemical traits of breast and leg muscles, as well as the fatty acid profile of intra-muscular fat were not affected by the applied supplements, although with some minor effects due to the sex of geese.

KEY WORDS: fatty acids / goose / liver / meat / selenium / vitamin E

Selenium (Se) is a trace element, which plays a key role in developmental, reproductive and immune functions of animal organisms [Schrauzer 2000]. Although this fact has been known since 1957, when Se deficiency was found to cause liver necrosis in rats and diathesis in chickens, studies on the use and role of this element in human and animal nutrition are still scarce. As selenomethionine, Se is an integral part of the glutathione peroxidase (GSH-Px) system involved in antioxidative mechanisms.

*Financially supported by the Polish Scientific Research Committee, Grant No. 2 P06Z 037 28.
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Selenium has a protective role towards vitamin E and it may partly replace it by binding free radicals responsible for neoplastic changes and ageing processes [Combs and Clarke 1999]. It is also considered to be a natural anticarcinogen [Combs 1989]. Dietary recommended daily allowance for selenium for women and men is 60 µg/day and 70 µg/day, respectively [Marzec *et al*. 2002, Sheng *et al.* 2002]. Marzec *et al*. [2002] determined the structure of Se intake from different food product groups in Poland and established that the main sources (27.2%) of selenium are meat and meat products. Feeding animals with elevated selenium is closely related to vitamin E, which in conjunction with Se limits the effect of stress on the immune system [Surai and Fisinin 2014]. As a natural antioxidant, Se is responsible for the maintenance of cell membrane stability.

Despite mineral contents and antioxidant properties of meat, considerable attention is given to fatty acid composition, which also determines the nutritional value of meat and poultry fat. Many studies have demonstrated opportunities to manipulate saturated (SFA) and unsaturated (UFA) fatty acids, since their composition and ratios depend partly on dietary intake [Poławska *et al*. 2011, 2013]. Humans can synthesize certain fatty acids, but are unable to de-saturate long-chain fatty acids [Ballabio and Restani 2012]. Our modern diets are low in n-3 fatty acids, leading to an increased n-6:n-3 fatty acid ratio. Consequently, this has been linked to many diseases, including cardiovascular diseases, abnormal skin tissue growth or neoplasms. The ratio of these two classes of polyunsaturated (PUFA) fatty acids should be distinguished, because they are metabolically and functionally distinct and have opposing physiological functions, important for homeostasis and normal development [Simopoulos 2000].

Although goose meat consumption is limited compared to chicken or turkey, particularly in Europe and North America, an increasing interest in the production and consumption of goose meat can be observed worldwide. For example, in China goose meat production increased between 1990 and 2009 from 0.474 to 2.3 million tons [Liu and Zhou 2013]. Goose fat is of high nutritional quality thanks to its significant contents of monounsaturated fatty acids (MUFA), high digestibility (93%) and caloric value, and contents of multiple vitamins [Biesiada-Drzazga 2006]. Since the main UFA sources include above-ground parts of plants, the intake of UFA in geese reared semi-intensively and fed green forages is much greater compared to intensively reared, rapidly growing chicken or turkey broilers [Wężyk *et al.* 2003]. Janicki *et al.* [2000] found that intensive feeding, in contrast to a semi-intensive system, resulted in significantly higher amounts of MUFA (60.09 *vs.* 58.24%) and significantly lower PUFA (10.41 *vs.* 11.83%) in abdominal fat of White Italian geese. Since poultry oxidizes UFA rapidly, feed supplementation with Se was documented to improve lipid stability of broiler meat by significantly increasing GSH-Px activity and decreasing TBARS (thiobarbituric acid-reactive substances) formation [Pappas *et al.* 2012, Skřivan *et al.* 2012]. Furthermore, Beer-Ljubić *et al.* [2012] established that higher dietary selenium levels significantly lowered cholesterol concentration in adipose tissue of chickens, while Kralik *et al.* [2012] reported that it reduced the total amount of MUFA and increased PUFA levels.

Studies on the role of selenium in waterfowl nutrition are scarce compared to other species of poultry or other farm animals. In Poland, goose breeding and production is a centuries-old tradition of economic importance. “Young oat-fattened Polish geese ™” are very popular and highly valued on the discriminating German market, which imports over 90% of Polish produced goose meat. The rearing system and length of the rearing period to produce oat-fattened Polish geese, which takes more than three times as long as broiler chickens, could benefit from feed supplementation to increase its economic value. Therefore, considering the importance of Se and Vit. E in growth and production of meat, as well as the potential impact on the composition and proportion of fatty acids, we decided to study the effect of feed supplementation with organic selenium and vitamin E on goose meat and liver quality.

Material and methods

Birds and their management

The experiment was conducted using commercial White Koluda® geese. Two hundred one-day-old goslings were selected from 1500 chicks and randomly divided into two dietary groups (five replicates: 10 males and 10 females each). The control group was fed basic feed (Tab. 1), while the experimental group was fed the basic feed supplemented with 0.3 mg/kg Se (as 300 mg of selenium yeast, -Sel-Plex, Alltech LTD, USA) and 100 mg/kg vitamin E (200 mg/kg of E-50 Adsorbate, Rolimpex S.A., Poland). Birds were fed full-ration feed up to week 13 of age, then both groups were feed the identical fattening/finishing system: one week more with oat grain (160 g/day/bird) and ground cereals (250 g/day/bird), followed with oat grain and ground cereals provided *ad libitum* to the 16th week of rearing. During the finishing-fattening phase of growth, it was not possible to accurately formulate the Se-Vit. E supplements. Also supplementation during that period was not approved for the market classification of “Young oat-fattened Polish geese”. Both groups of birds were reared in a semi-intensive system, *i.e.* during the first 3 weeks goslings were kept indoors under controlled environment conditions (temperature, light program, humidity) [Łukaszewicz *et al.* 2008]. Then, up to 16 weeks of age, goslings were reared in an open house with free access to a grass field. Drinking water was provided *ad libitum*.

Sampling and evaluation of physical characteristics of meat

At 16 weeks of rearing (day of slaughter), all birds were weighed individually (accurate to 5 g) and a subset of 20 birds (10 males and 10 females having body weight closest to the average weight for sex within each group) were chosen from each group for further analysis. After 12 hours of feed withdrawal (access to drinking water was allowed), geese were slaughtered in a national slaughter facility for waterfowl. Further *post-mortem* analyses were performed after 24 hours of cooling at +4°C. Breast (*pectoralis major* and *p. minor*, collected from the left side) and leg meat (left thigh and shank together) were ground, homogenized and subjected to further

Table 1. Composition of basic (control) feeds used for White Koluda® geese rearing (in 1 kg of feed)*

Item	Starter (1-3 wk.)	Grower (4-9 wk.)	Finisher (10-13 wk.)
Ingredients			
ground maize (%)	20.20	20.80	22.00
ground triticale (%)	10.00	10.00	5.00
ground barley (%)	5.00	10.00	5.00
ground oats (%)	--	6.00	20.00
ground naked oats (%)	14.00	7.00	5.00
ground wheat (%)	14.00	5.00	5.00
rapeseed meal, solvent-extracted (%)	5.00	10.00	4.00
soybean meal, solvent-extracted (%) (42-46% CP in DM)	28.00	10.00	2.00
wheat bran (<9% CF) (%)	--	18.00	29.70
calcium carbonate (%)	1.20	0.65	0.70
NaCl (%)	0.10	0.05	0.10
P 2.5% KW1**	2.50	2.50	1.50
Chemical composition			
metabolizable energy (MJ)	11.15	10.70	10.73
crude protein (g)	202.26	170.03	135.57
crude fat (g)	30.29	31.19	35.34
crude fiber (g)	44.40	51.48	54.78
Amino acids			
lysine (g)	10.84	8.35	5.77
methionine (g)	4.53	4.24	3.09
methionine + cystine (g)	6.99	6.36	5.14
threonine (g)	7.41	6.16	4.61
tryptophan (g)	2.41	2.08	1.71
Mineral elements			
calcium (g)	9.39	7.25	5.57
total phosphorus (g)	7.46	8.73	7.68
assimilable phosphorus (g)	4.09	4.45	3.44
Na (g)	1.85	1.69	1.44
Cl (g)	0.96	0.68	1.06
Mg (mg)	104.72	117.61	94.15
I (mg)	1.00	1.00	0.60
Cu (mg)	11.40	10.72	8.38
Fe (mg)	165.56	146.01	122.96
Zn (mg)	97.53	105.45	78.48
Se (mg)	0.15	0.15	0.09
Vitamins			
A (IU)	556	718	793
D_3 (IU)	--	--	--
E (g)	8.31	11.41	14.75
Choline (mg)	1819.30	1946.10	1420.35

*Feed analysis was made at the Local Feed Laboratory in Lublin, Poland.

**1 kg vitamin-mineral premix Vitfoss P 2.5% KW 1 contains: dry matter - 24.0 g; Ca - 3.40 g; total phosphorus - 3.13 g; assimilable phosphorus - 2.75 g; Na - 1.25 g; Fe - 45.0 mg; Zn -70.0 mg; Cu - 5.0 mg; J - 1.0 mg; Se - 0.15 mg; Co - 400.0 mg; lysine - 0.7 g; methionine - 1.4 g; vit. K_3 - 3.2 mg; vit. B_1 - 2.4 mg; vit. B_2 - 9.0 mg; vit. B_6. - 7.0 mg; vit. B_{12} - 70.0 mg; pantothenic acid - 16.0 mg; folic acid - 2.4 mg; biotin - 0.24 mg; choline - 450.0 mg.

analyses. The smaller lobe of liver was used to quantify dry matter (%), selenium (mg/kg) and vitamin E (µg/100 g) contents.

Chemical analyses

Chemical analyses of meat (breast and leg muscles) and liver were conducted at the Accredited Laboratory in the Sea Fisheries Institute in Gdynia, Poland (Accreditation Certificate no. AB 017 awarded by the Polish Centre of Accreditation), according to methodology outlined in AOAC [1999] and Polish standards: protein - PN-75/A-04018, fat - PB-07, ash - PB-15 and selenium - PN-EN 14627 (IM-33/AAS). The fatty acid profile (in the form of methyl esters, FAME, EN ISO standard 5509:2000; www.iso.org) was evaluated by gas chromatography as described by Christopherson and Glass [1969]. Chromatographic analyses were performed on a 6890N SC system gas chromatograph coupled with a 5973 MS mass spectroscopy detector (Agilent Technologies Inc., Palo Alto, USA) and a Supelco SP-2560 capillary GC column (*L* x I.D. 100 m x 0.25 mm, d_f 0.20 µm (SUPELCO, Bellefonte, USA). The following oven program was used: initial temperature 140°C (2 min), increase by 2°C/min up to 225°C and isotherm for 10 min, increase by 4°C/min up to 240°C and isotherm for 10 min. Samples of 2 µL were injected in the split mode (100:1). Injector and detector temperatures were 250°C and 260°C. Helium was used as the carrier gas and nitrogen as the make-up gas. The carrier gas flow rate was 1.1 mL/min. Common fatty acids were identified by comparing sample peak retention times with those of FAME standard mixtures (47885-U SUPELCO; Sigma-Aldrich Chemie GmbH, Schelldorf, Germany), *cis*-5,8,11,14,17-eicosapentaenoic acid methyl ester (47571-U SUPELCO; Sigma-Aldrich Chemie GmbH, Schelldorf, Germany) and *cis*-4,7,10,13,16,19-docosahexaenoic acid methyl (05832 FLUKA; Sigma-Aldrich Chemie GmbH, Schelldorf, Germany). Analyses were performed in duplicate, 24 hours after sample collection, and the results for each fatty acid were expressed as g per 100 g total fatty acids.

The presented experiment was approved by the II Local Ethics Commission for Experiments Carried on Animals in Wroclaw at Wroclaw University of Environmental and Life Sciences, Chełmońskiego 38c, 51-630 Wroclaw, Poland; permission nr 84/04.

Statistical analysis

Obtained data were statistically analysed using a two-way ANOVA model with main effects of the diet group (control *vs.* experimental feeds) and sex (males and females) including interactions. Data were tested for normal distribution and homogeneity of error variances to meet requirements of ANOVA General Linear Models Procedure of SAS [SAS Institute, Cary, USA]. Duncan's multiple range test was used to separate means, for which significant interactions were identified.

Results and Discussion

It is well known that poultry meat is a source of proteins, vitamins, enzymes, glycogen and sugars. From the point of view of human health, meat with an increased Se content can be a valuable food product, supplementing the human diet with this element, especially in areas deficient in Se. Among people living in regions with a lack or deficiency of selenium, an increased frequency of cardiomyopathy and osteoarthropathy, prevalence of cancer and heart attacks is often observed. Depending on the country or region, the current recommended dietary intake of Se for adult men and women ranges from 30 to 85 µg/day and from 30 to 70 µg/day, respectively [Rayman 2004].

Statistical evaluation of results presented for this experiment confirmed that there were no significant differences due to the interaction of the diet group with the sex of geese for any of the investigated characteristics.

Selenium content in goose meat

The results of our study indicate a potential to produce goose raw materials with increased selenium contents without detrimental effects on physical characteristics of breast and leg meat. Commercial feeds supplemented with 0.3 mg/kg of organic selenium and 100 mg/kg of vitamin E and applied from the 1st to 13th week of rearing increased significantly ($P \leq 0.01$) the selenium concentration in breast and leg meat of 16-week-old White Koluda® geese (Tab. 2 and 3). Sex had no effect on Se accumulation in the meat; however, significant effects were found for the diet group. Dietary supplementation of Se and Vit. E significantly ($P \leq 0.01$) increased Se levels in breast and leg meat in the diet groups when compared to the control. Selenium content in the experimental diet groups increased in breast meat (0.162 *vs*. 0.098 mg/kg in control males and 0.170 *vs.* 0.087 mg/kg in control females) and in leg (0.190 *vs.* 0.082 mg/kg in the control and 0.161 *vs.* 0.067 mg/kg, in males and females, respectively). These findings are consistent with studies conducted on gray geese [Baowei *et al*. 2011] and other poultry species, such as chicken or turkey [Skřivan *et al.* 2008a, 2008b, Wang and Xu 2008, Mikulski *et al.* 2009, Wang 2009].

In our experimental group the selenium content increased approx. 1.88-fold in the breast and 2.25-fold in the leg meat when compared to the control. However, this increase was lower than that presented by Baowei *et al.* [2011] in breast muscles of the same species (an increase from 0.14 to 0.47 mg/kg, *i.e*., 3.36 times). This was possibly due to the consumption of grass in the semi-intensive rearing system, or a lack of supplementation during our final 3-week fattening phase, when geese were fed with oat grain and ground cereals exclusively, thus reducing the difference between the control and experimental feed groups. While a higher level of Se supplementation may have produced results more comparable to other published studies, we felt 0.3 mg/kg was appropriate as it matched many studies, avoiding potential Se toxicity. In broiler chickens Ševčikova *et al.* [2006] reported an increased Se level from 52.11 to 217.39 µg/kg. A similar result for Se contents was reported by Skřivan *et al.* [2008b], increasing from 0.39 to 1.01 mg/kg dry matter (DM), *i.e*., 2.59-fold, and from 0.47 to 1.25 mg/kg DM (2.66 times) in breast and leg muscles of broiler chickens, respectively. Turkey breast meat benefited by a 2.9-fold increase in Se levels from 0.42 to 1.22 ppm [Invernizzi *et al*. 2013], which was substantiated by Mikulski *et al.* [2009], who observed the same magnitude of increase in Se content from 0.468 to 1.60 mg/kg also in turkey breast. The reported variations in meat Se contents depend not only on species, but are also observed between muscles of the same species. Daun and Akesson [2004] concluded that muscle selenium contents can vary approximately 2-fold among species. They also reported differences in Se contents among muscles of the same species. Selenium content in lamb *m. psoas major* was recorded to be significantly greater than in other lamb muscles (breast, thigh, steak and fillet), while it was greater than in chicken, turkey and ostrich meat. The observed exception was for duck breast, which contained significantly more selenium than chicken and turkey breast and thigh muscles, ostrich muscles (steak and fillet) and lamb *longissimus dorsi*. Among birds, the lowest selenium concentration was reported in turkey breast. In our experiment, muscle Se content was affected neither by sex nor type of muscle (Tab. 2).

Table 2. The effect of dietary organic selenium and vitamin E supplementation on chemical composition of breast and leg muscles of 16-week-old White Koluda® goose (n=10; means)

Traits		Breast muscles				Leg muscles (thigh and shank together)			
	group	selenium (mg/kg)	protein (%)	fat (%)	ash (%)	selenium (mg/kg)	protein (%)	fat (%)	ash (%)
♂	control	0.098	21.37	6.027	1.197	0.082	20.31	9.017	1.045
	experimental	0.162	21.47	7.005	1.197	0.190	20.52	9.252	1.052
♀	control	0.087	22.06	5.178	1.241	0.067	20.28	9.317	1.043
	experimental	0.170	21.98	5.053	1.280	0.161	20.06	9.358	1.057
SEM		0.009	0.106	0.216	0.008	0.011	0.091	0.120	0.007
P value	sex	0.926	<0.01	<0.001	<0.001	0.336	0.186	0.620	0.914
	diet	<0.001	0.961	0.335	0.289	<0.001	0.982	0.736	0.515
	sex x diet	0.437	0.614	0.086	0.093	0.303	0.248	0.747	0.535

Chemical composition of goose breast and leg meat

Basic feed supplementation with selenium and vitamin E had no significant effect on protein, fat and ash contents either in breast or leg meat (Tab. 2). Significant differences in protein, fat and ash percentages were caused by the sex of geese. A sex effect was observed for ash in breast meat of both groups ($P \leq 0.01$), with females having higher ash contents than males, and fat content of the experimental groups ($P \leq 0.01$). Also breast muscles of females from the control group contained a higher percentage ($P \leq 0.05$) of protein when compared to meat of males. These results are consistent with those presented by Baowei *et al.* [2011] on geese and Mikulski *et al.* [2009] using turkeys. Those authors reported no effect of dietary addition of selenium yeast on protein, fat and ash contents in muscle. Also Körösi-Molnar *et al*. [2004] found no significant selenium or vitamin E impact on protein and ash contents in pectoral muscles of fattened geese. Ševčikova *et al.* [2006] described a dual effect of organic selenium, the same magnitude as in our experiment, on the chemical composition of broiler chicken meat. No differences (P≥0.05) in the proximate composition were apparent in leg meat due to either sex or diet group.

Selenium content and chemical composition of goose liver

The liver is considered to be the main organ accumulating selenium [Wang 2009], which was confirmed in our study. Livers of geese in the control group, *i.e.* fed basic feeds only, contained more selenium than muscle of the experimental group, *i.e.*, receiving Se and Vit. E supplementation (Tab. 3). Selenium level in livers of the experimental group geese was 1.68-fold higher (0.367 *vs.* 0.221 mg/kg in males and 0.369 *vs.* 0.224 mg/kg in females, experimental *vs*. control, respectively) than in livers of birds fed the basic feeds (Tab. 3). Similarly to meat, Se concentration was lower than in gray goose liver [Baowei *et al*. 2011], which increased from 0.44 to 1.29 mg/kg, representing a 2.93-fold increase due to Se supplementation. The effect of yeast-Se supplementation (0.3 mg/kg) on livers of broiler chickens [Ševčikova *et al.* 2006] was manifested in an increase of Se levels from 185.37 to 424.23 µg/kg, as found in the results provided by Wang *et al*. [2011]. More than a 2-fold increase in Se concentration was shown by Skřivan *et al.* [2008b] - from 1.11 to 2.41 mg/kg DM in chicken liver. The lowest Se concentration (a 1.35-fold increase from 1.36 to 1.84 ppm) was described by Invernizzi *et al.* [2013] in livers of laying hens fed the diet containing selenium yeast at 0.4 mg Se/kg of feed. According to Combs and Combs [1986], the liver contains about four times as much selenium as skeletal muscle. Both in our and other studies, the existing differences in Se contents between liver

Table 3. The effect of dietary organic selenium and vitamin E supplementation on chemical composition of 16-week-old White Koluda® goose liver (n=10; means)

Trait		Selenium (mg/kg)	Vitamin E (µg/100 g)	Dry matter (%)
♂	control	0.221^{A}	47.07	30.31
	experimental	0.367^{B}	102.55	29.93
♀	control	0.224^{A}	33.07	30.54
	experimental	0.369^{B}	70.50	30.90
SEM		0.019	13.556	0.165
P value	sex	0.950	0.408	0.690
	diet	<0.001	0.870	0.975
	sex x diet	0.987	0.738	0.262

^{AB}In columns, within sex (between groups - diet effect) means bearing different superscripts differ significantly at P≤0.01.

and meat were not as high and they varied between authors. Selenium content in the examined goose livers was 2.17 times greater than in breast muscle, and increased 2.05 times when compared to leg muscle. Baowei *et al*. [2011] reported that selenium concentration in gray goose livers was 2.74 times higher (1.29 *vs*. 0.47 mg/kg) than in breast muscles, while Ševčikova *et al.* [2006] showed that livers of chicken broilers contained 1.95 times more selenium (424.23 *vs*. 217.39 µg/kg) when compared to pectoral muscles, and 1.71 times (424.23 *vs*. 247.87 µg/kg) that of thigh muscle. It is not clear whether this is due to the longer production period of geese, the semi-intensive rearing or the lack of supplementation during the final fattening phase, independently or in combination.

Selenium addition had no significant (P≥0.05) effect on either dry matter or vitamin E contents of liver (Tab. 3). Although the amount of vitamin E in livers of the experimental groups (males and females) was two times greater than in the controls, its stability was very low, which could affect the final results.

Fatty acid profile in goose breast and leg meat

The addition of organic selenium and vitamin E to the diets of geese reared to 16 weeks of age showed no significant (P≥0.05) effect on fatty acid contents and profiles in breast (Tab. 4) and leg meat (Tab. 5). However, differences in fatty acid profiles were observed for the type of muscles and sex of geese. As in studies on goose breast and leg meat conducted by other authors [Biesiada-Drzazga 2006, Biesiada-Drzazga *et al*. 2010, Kralik *et al.* 2012, Okruszek 2012], the SFA and MUFA were predominant components, while the concentration of PUFA was relatively low. Although not indicated in Tables 4 and 5 (for "technical" reasons and to avoid unnecessary repetition) we made the statistical comparisons of fatty acid contents in breast and leg meat of relevant male and female groups. They demonstrated that breast meat of males and females in our experimental groups were characterized by higher (P≤0.01) contents of PUFA (19.90% and 20.08% in male and female breast meat *vs.* 16.26% and 16.30% in leg meat, respectively); n-6 (18.70% and 19.17% in breast *vs.* 15.16% and 15.23% in leg muscles) and hypocholesterolemic fatty acid (DFA: 72.30% and 72.13% *vs.* 69.73% and 69.20%), when compared with thigh and shank meat. In contrast, for MUFA (39.78% and 40.80% *vs.* 43.81 and 43.52%, for males and females in breast and leg meat, respectively), and hypercholesterolemic fatty acids (OFA; 26.95% and 27.30% *vs.* 29.86 % and 30.35%, respectively), opposite relationships were observed (Table 4 and 5). A sex effect (P≤0.01) was observed only for n-6 in breast meat of the experimental groups, with females having higher n-6 contents than males (Table 4). Okruszek [2012] analysed Polish geese from two genetic reservoir flocks (Rypińska and Garbonosa). He described higher total SFAs in breast meat, while in leg meat the total UFA, including MUFA, PUFA, n-6 and n-3 were dominant. Although we observed no significant effect of Se and vitamin E on n-3 contents, it should be pointed out that the highest level (1.20%), was measured in breast of males from the experimental group. Kralik *et al.* [2012] reported that the addition of 0.3 mg Se/kg on

Table 4. The effect of dietary organic selenium and vitamin E supplementation on fatty acid composition (%) of breast muscles of 16-week-old White Koluda® goose (n=10; means)

Trait	Group	SFA	MUFA	PUFA	UFA	n-3	n-6	DFA	OFA	PUFA/SFA
♂	control	40.10	40.17	19.73	59.90	1.017	18.72	71.58	27.53	0.494
	experimental	40.32	39.78	19.90	59.68	1.200	18.70**	72.30	26.95	0.492
♀	control	39.52	39.78	20.70	60.48	1.083	19.62	72.30	26.65	0.524
	experimental	39.12	40.80	20.08	60.88	0.917	19.17**	72.13	27.30	0.514
SEM		0.212	0.195	0.179	0.212	0.049	0.169	0.252	0.264	–
P value	sex	0.320	0.429	0.111	0.320	0.227	<0.05	0.597	0.625	– no value
	diet	0.835	0.429	0.543	0.835	0.934	0.503	0.597	0.951	–
	sex x diet	0.454	0.077	0.275	0.454	0.078	0.509	0.401	0.274	–

**In columns, within groups (between sex) means differ significantly at P≤0.01.

Table 5. The effect of dietary organic selenium and vitamin E supplementation on fatty acid composition (%) of leg muscles (thigh and shank together) of 16-week-old White Koluda® goose (n=10; means)

Trait	Group	SFA	MUFA	PUFA	UFA	n-3	n-6	DFA	OFA	PUFA/SFA
♂	control	39.55	44.25	16.20	60.45	1.082	15.12	70.35	29.13	0.410
	experimental	39.90	43.81	16.26	60.08	1.097	15.16	69.73	29.86	0.407
♀	control	39.80	43.63	16.57	60.20	0.780	15.78	70.07	29.63	0.416
	experimental	40.18	43.52	16.30	59.82	1.070	15.23	69.20	30.25	0.406
SEM		0.109	0.121	0.155	0.109	0.066	0.150	0.206	0.215	–
P value	sex	0.244	0.060	0.532	0.244	0.214	0.235	0.332	0.315	– no value
	diet	0.085	0.266	0.755	0.085	0.249	0.412	0.070	0.119	–
	sex x diet	0.969	0.496	0.616	0.969	0.289	0.334	0.756	0.892	–

the one hand caused a significant decrease in the amount of MUFA, and on the other hand, a significant increase in n-6 and n-3 in broiler breast muscles.

According to FAO and WHO, the PUFA/SFA ratio in human diets should amount to 0.45. Therefore, from the point of view of human health, results concerning the PUFA/SFA ratio (0.5 in breast and 0.4 in leg muscles) and amounts of DFA and OFA seem very interesting. Higher PUFA/SFA ratios were observed by Liu and Zhou [2013] in breast muscles of male Dongbei White Geese, which could be influenced by pasture forage intake. In a study of Beer-Ljubić *et al.* [2012], dietary supplementation with organic selenium (Sel-Plex) resulted in decreased cholesterol levels in chicken adipose tissue, which they postulated could be due to a reduced cholesterol resorption or a faster elimination of resorbed cholesterol in the form of lipoproteins from enterocytes.

This experiment was conducted under the standards for producing "young oat-fattened Polish geese ™" using organic Se and Vit. E. Summarising, the results obtained indicate that goose feed supplementation with organic selenium and vitamin E had little or no impact on breast and leg meat proximate chemical composition, while improving selenium content of goose raw materials (meat and liver) and providing a valuable source of natural antioxidants in the human diet. A lack of any apparent effect of Se and Vit. E addition on fatty acid profiles in the meat of 16-week-old geese may result from the production technology for these geese. According to this technology, during the last three weeks of finishing fattening birds receive *ad libitum* only oat grain and ground cereals, so no antioxidants were added in that period. Our previous studies on Se and Vit. E addition to White Koluda® goose diet showed their significant and positive impact on body weight during the rearing period (age 7 to 91 days). In that study, body weight of the experimental group was greater when compared to the control at the end of the growing period; however, after the 3-week finishing period differences in final body weight were not significant [Łukaszewicz *et al*. 2011].

Acknowledgments. *The authors are very thankful to Janet Eastridge from the Animal Biosciences and Biotechnology Laboratory, Agricultural Research Service, the U.S. Department of Agriculture, Beltsville, Maryland, USA, for her critical review of the manuscript.*

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