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Effects of Different Amounts of Blue Lupine (L. angustifolius L.) in the Diets of Heavy-Type Turkeys on Their Growth Rate, Carcass and Meat Qualities

■Author(s)

Juodka R[I]
Nainiene R[I]
Juskiene V[I]
Juska R[I]
Stuoge I[I]
Leikus R[I]

[I] Animal Science Institute of Lithuanian University of Health Sciences; R. Zebenkos 12, Baisogala, LT-82317 Radviliskis district, Lithuania

■Mail Address

Corresponding author e-mail address
Robertas Juodka
Department of Ecology, Animal Science Institute of Lithuanian University of Health Sciences, R. Zebenkos 12, Baisogala, LT-82317 Radviliskis district, Lithuania
Tel: (+370) 61535692
Email: robertasjuodka@gmail.com

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ABSTRACT

A study was carried out to determine the effects of soybean meal replacement with different amounts of blue lupine in the diets of turkeys on the growth rate, anatomic carcass dissection data, chemical indicators of breast and thigh muscles and the content of tryptophan and oxyprolin. In total three hundred and sixty cross BIG-6 turkeys were allotted to two control and ten experimental groups of 30 one-day-old turkeys. The control group of turkeys was fed the diet containing soybean meal, whereas the trial groups were offered different amounts (from 20 to 30%) of lupines. Group 4 and 5 were additionally given probiotic mixture Bio Plus 2B and allzyme SSF, respectively. Soybean oil replacement from 20 to 30% lupine in the diet had no influence on the growth rate, dressing percentage, edible parts and abdominal fat content of turkeys. The study indicated that lupines in the diet of turkeys had a different effect on the meat quality of different genders. Lupines did not have any negative effect on the meat quality of female turkeys and 30% lupines even improved the protein value index of breast muscles. However, 20–30 and 25–30% lupines in male turkey diets lowered dry matter and protein contents in breast muscles but had no negative influence on the main quality indicators in thigh muscles. The results of the study showed that the negative effect on the male breast muscle quality might be avoided using Bio Plus 2B or allzyme SSF additives in the male diets containing 30% lupines.

INTRODUCTION

In many European Union (EU) countries, including Lithuania, most of the protein feeds for commercial poultry breeding are imported from abroad, because it is impossible to completely supply the branch with home-grown feeds. Soybean meal is the commonly used source of dietary protein in poultry feed formulations around the world (Nalle, 2009) and, furthermore, it´s content in the compound feeds for poultry amounts to 45%. However, it is indicated that 98% of soybean meal or cake are produced from genetically modified plants (Sieradzki *et al*., 2006). Poultry consumers in Lithuania like in other EU countries express negative opinions about the use of GMO, and, besides, the demand for organic food is increasing. Yet, the diet containing exceptionally high protein content (up to 26–28%) is needed for growing heavy-type broad breast turkey-poults. With respect to the above-mentioned drawbacks of soya usage, the necessity arises to search for the alternative protein sources in poultry feeds that could completely or partially replace soya components in poultry feed formulation (Nalle, 2009). It would be highly desirable for farmers to supply poultry with local protein feeds. In case local feeds were used for poultry growing, the meat would become cheaper and the engagement of people working in agriculture

would be higher as well. An alternative protein source for soybeans might be lupines (*Lupinus* spp.). Lupines possess good agronomic characteristics which makes it more appealing to cultivate than soybeans, and they have no anti-nutritive factors, such as trypsin-inhibitor (Olver, 1987). The protein from lupines has all indispensable amino acids and are well-digestible (Sujak *et al.* (2006). Birds fed lupines had a low mortality rate and low relative pancreatic weight, confirming that the level of anti-nutrients in these legume seeds was low in comparison with soybeans (Nalle, 2009). Moreover, sweet lupines are the cheapest home grown feeds (Leikus *et al*., 2004). However, the worldwide production of lupine grain seeds is low, and amounted to about 0.01 % of the worldwide production of soybeans (Mittermaier, 2013).

Australia is the country with the highest level of lupine growing and exportation, which represents 75.3% of global production (Lucas *et al*., 2015). In the EU, lupine production makes up 17.6% of the global production with Poland being the leader (77799–126200 tons annually in 2010–2013) and Germany the second in the production of lupines (27660–31500 tons annually in 2010–2013) (Faostat, 2015; Lucas *et al*., 2015). Undoubtedly, the areas with lupines will be increasing in Lithuania as well due to the development of organic agriculture and animal production, whereas currently the production of sweet lupines in our country is low, i. e. 3800 tons in 2013 (Faostat, 2015). One of the most popular species of lupines in our country is the narrow-leafed lupine. 'Bora' is a narrow-leafed alkaloid-free variety of blue lupines developed in Germany. Several studies can be found on the efficiency of lupines in the diets of different species of animals and birds, but there is no unanimous agreement regarding the highest possible amount of blue lupines in the diets of heavy-type turkeys.

The studies of Mierlita (2014), Zdunczyk *et al*. (2014) and Krawczyk *et al*. (2015) indicated that from 6 to 30 % lupine in the turkey diets had no influence on their body weight if compared with lupine-free diets. Mierlita (2014) concluded that substituting soybean protein meals with white lupine beans in turkey broilers at a rate from 20 to 30% had no adverse effects on the slaughter indices, however, the diet containing over 30% of lupines had a negative impact on carcass features. Zdunczyk *et al.* (2014) indicated that the slaughter value of turkeys was not affected by feeding them 6 to18% sweet yellow lupine meal in comparison with the diet containing soybean meal. This is in agreement with the studies of Krawczyk *et al*. (2015) who carried out trials with turkeys fed 8 to 24% yellow lupine meal.

The studies of the effect of lupines on the chemical indicators of goslings and chicken meat showed that 5-20% of lupines in the feed had no influence on the above meat indicators and on the contents of tryptophan and oxyprolin (Morkunas *et al*., 1995; Vaitiekunas *et al*., 1996; Morkunas, 2002).

Currently, the demand for organic fowl is increasing both in Europe and Lithuania. Also, the birds are grown by Label Rouge programme mostly in France, according to which the ration composition is based principally on locally produced feed (Sundrum *et al.*, 2005). As it is not allowed to use genetically modified soya products in organic farming, the use of lupines for poultry feeding would reduce the shortage of protein feeds and allow reaching high protein content necessary for feeding turkey poults. For these farms, balanced diets are the major difficulty under the organic farming standards (Rahmann & Böhm, 2005). However, the available information is insufficient to develop the diets with blue lupines, that have no negative influence on the qualitative and quantitative indicators of meat.

The purpose of our study was to determine the efficiency of different amounts of blue narrow lupine seed meal in the diets for hybrid cross BIG-6 turkeys, to analyze the effects of the lupine content on the growth rate of turkeys, anatomic carcass dissection data and chemical indicators of breast and thigh muscles; and to determine the contents of tryptophan and oxyprolin in above muscles.

MATERIAL AND METHODS

Birds and experimental treatments

The study was carried out on a Tamosiunas turkey farm district of Anyksciai, Lithuania. A total of three hundred and sixty cross BIG-6 turkeys were assigned to two control groups (one male and one female) and ten experimental groups (five males and five females) of 30 one-day-old turkeys each (Table 1). The diet of the control group turkeys contained soybean meal, which for the turkeys was replaced by respectively 20, 25 and 30% 'Bora' variety blue narrow-lupine in Trial group 1,Trial group 2 and Trial groups 3, 4 and 5. Besides, the diet of the turkeys in Trial Group 4 was supplemented with 200 g of probiotic mixture Bio Plus 2B per 1000kg of feed at all age periods. The diet of the turkeys in Trial group 5 was supplemented with 200 g allzyme SSF per 1000kg of feed. Starting from 13 weeks, there was no genetically modified soybean

meal in the diets of turkeys in Groups 3, 4 and 5. For all the groups, the amounts of lysine, methionine and threonine were respectively 16, 10.5 and 10.4 g per kg feed at the age of 0–4 weeks, from 5 to 8 weeks it was 14, 9.0 and 9.0 g, and from 9 to 12 weeks 12.1, 6.5, 7.9 g and from 13 to 16 weeks – 9.0, 5.2 and 6.3 g. During experimental period, water and feed were provided *ad libitum.* All birds were reared under the same conditions. The investigations were conducted in accordance with the law of the Republic of Lithuania for animal welfare and handling, Law No.IX-2271 (State News, 2012) and a sub-statutory act by the State Food and Veterinary Service of Lithuanian Republic regarding the confirmation of the order on the animals for experiments, research, storage, maintenance and operating requirements (State News,2012).

Table 1 – Experimental design

Age week	Protein content of feed (%)	Metabolizable energy, MJ/kg	Control group	Group 1	Group 2	Group 3	Group 4/5
			Soybean oil-meal content in the diet (%)	Soybean oil-meal + lupine content in the diet (%)			
0–4	27	11.1	36.5	22.4+20	18.8+25	15.3+30	15.3+30
5–8	25.1	11.1	36.0	21.9+20	18.4+25	14.9+30	14.9+30
9–12	22.8	11.3	29.5	15.4+20	11.9+25	8.3+30	8.3+30
13–16	18.5	11.3	21.2	7.1+20	3.5+25	0+30	0+30

Growth rate, carcass traits and meat quality

Birds of all groups were weighed at 4, 8, 12 and 16 weeks of age. At the age of 16 weeks, three males and three females of average weight were chosen from each group for control slaughtering. Prior to slaughter, the birds had not been fed for 12 hours. Carcasses were anatomically dissected according to the methodological recommendations of anatomic carcass dissection and organoleptic evaluation of poultry (Lukashenko *et al.*1984). The chemical composition of meat was analyzed by standard AOAC methods (1990). The contents of tryptophan and oxyprolin in meat were determined by the methods of Marina & Shut (1970) and Kolar (1990). All analytical studies were carried out at the Analytical Laboratory of the Animal Science Institute of Lithuanian University of Health Sciences.

Data analysis

Processing of the data was performed using software Statistica (Data Analysis Software System, Version 7.0; StatSoft, Inc., Tulsa, OK, USA). The statistical evaluation of the results was performed using descriptive statistics and Student's t test for independent samples. In the tables, all of the data are displayed as mean (x) ± standard error (SE) of mean. The probability level of $p< 0.05$ was considered to be statistically significant.

Table 2 – Effect of different amounts of blue lupine in the diets of turkeys on the growth rate of male turkeys, g

Age	Group					
	Control	Group 1	Group 2	Group 3	Group 4	Group 5
Body weight						
4 week	1232.80±17.53	1272.73±23.49	1245.27±20.79	1193.90±13.63	1216.40±21.17	1264.57±10.13
8 week	4817.67±54.13	4989.33±34.48	4956.33±46.65	4900.00±48.55	4995.33±70.62	4869.67±52.31
12 week	10132.61±357.74	10460.42±205.87	10014.29±139.70	10209.62±168.52	10517.33±192.72	10484.21±192.41
16 week	15750.00±620.08	15283.75±558.85	16000.00±352.87	16193.75±375.11	15993.75±556.16	15362.50±271.24
Average total gain						
0-4 week	1177.91	1218.46	1190.73	1139.07	1161.97	1210.08
5-8 week	3614.87	3625.60	3711.06	3706.10	3778.93	3605.10
9-12 week	5314.94	5562.09	5057.96	5309.62	5522.00	5614.54
13-16 week	5617.39	4823.33	5985.71	5984.00	5476.42	4878.29
Total gain	15695.11	15229.48	15945.46	16138.92	15939.32	15307.91
Average daily gain						
0-4 week	42.07	43.52	42.53	40.68	41.50	43.22
5-8 week	129.10	129.54	132.54	132.36	134.96	128.75
9-12 week	189.82	198.65	180.64	189.63	197.21	200.52
13-16 week	200.62	172.26	213.78	213.71	195.59	174.22
Average (0-16 week)	140.13	135.98	142.37	144.10	142.32	136.68

±SE – standard error

RESULTS AND DISCUSSION

Lupine Bora

In our study, the turkeys of both genders were fed 'Bora' variety lupines. This variety of lupines contained 1% bitter lupine seeds, 94.12% dry matter, 5.12% crude fat, crude protein 37.22%, crude fibre 13.32%, crude ash 3.09%. These contents were similar to those indicated for *L.angustifolius* in general (Nalle, 2009; Mittermaier, 2013).

Growth rate

There was no significant difference between male and female weights at the age of 4, 8, 12 and 16 weeks in both control and treated groups (Table 2, 3). The results of our study are in agreement with those of Mierlita (2014), Zdunczyk *et al*.(2014), Krawczyk *et al*. (2015), who indicated that lupine in the diet of heavy-type turkeys had no adverse effect on their body weight. However our results do not agree with the findings of Mikulski *et al*. (2014), who indicated that the use of blue lupine in the diet had resulted in significantly higher body weight of turkeys.

Table 3 – Effect of different amounts of blue lupine in the diets of turkeys on the growth rate of female turkeys, g

Age	Group					
	Control	Group 1	Group 2	Group 3	Group 4	Group 5
Body weight						
4 week	1043.10±10.28	1018.00±10.89	1077.73±14.36	1021.57±9.81	1061.07±9.70	1048.68±7.97
8 week	3727.00±29.73	3646.33±27.70	3670.60±32.82	3751.72±26.04	3642.33±31.87	3839.00±52.15
12 week	7597.67±96.37	7688.89±155.37	7565.38±44.36	7511.54±88.81	7608.70±45.73	7454.00±67.68
16 week	11238.10±250.76	10955.56±347.94	11788.89±119.61	11572.22±163.66	11938.89±261.74	11368.00±159.67
Average total gain						
0-4 week	990.18	964.83	1024.93	968.07	1007.57	995.65
5-8 week	2683.9	2628.33	2592.87	2730.15	2581.26	2790.32
9-12 week	3870.67	4042.56	3894.78	3759.82	3966.37	3615.00
13-16 week	3640.43	3266.67	4223.51	4060.68	4330.19	3914.00
Total gain	11185.18	10902.39	11736.09	11519.00	11885.39	11314.97
Average daily gain						
0-4 week	35.36	34.46	36.60	34.57	35.98	35.56
5-8 week	95.85	93.87	92.60	97.51	92.19	99.65
9-12 week	138.24	144.38	139.10	134.28	141.66	129.11
13-16 week	130.02	116.67	150.84	145.02	154.65	139.79
Average (0-16 week)	99.87	97.34	104.79	102.85	106.12	101.03

±SE – standard error

Anatomic carcass dissection_data

The different amounts of blue lupines in the diets of turkeys had no effects on the dressing percentage (Table 4), except for the significant difference between the control and Group 4 male turkeys fed diets containing 30% lupines and probiotics (+3.95%; $p<0.05$).

Büttner & Oster (2004) and Siudikas *et al*. (2010) have mentioned that supplementation of the feed for fattening pigs with 0.06% or 2.5–3.0% probiotic Bioplus 2B had no influence on the dressing percentage. Feeding chickens lupines or no-lupines resulted in no significant difference for the dressing percentage in the studies by Nalle (2009) (20% lupines), Morkunas *et al.* (1995) (5–20% lupines), Olver (1987) (40% white lupine, variety 'Buttercup'), Bekric *et al.* (1990) (23% lupine, variety 'S-14') and Orda *et al.* (2006) (5–20% yellow lupine, variety 'Sonet'). Similar findings were observed in the studies by Witak *et al.* (2006) on feeding duckling's 2.5–15% yellow lupine, Mierlita (2014) on feeding male turkeys 20–30% white lupine (variety 'Energy'), Mikulski *et al.* (2014) on feeding male turkeys 6–18% blue lupine (variety 'Sonet') and Krawczyk *et al.* (2015) on feeding female turkeys 8–24% yellow lupine (variety 'Baryt').

Contrary findings, i. e. higher dressing percentage values when feeding lupines, were reported by Morkunas (2002) in his study with goslings fed 20% lupines and Mierlita (2014) in the trials with male turkeys fed 40% white lupines (variety 'Energy').

In our study, there were no differences found for the internal edible parts in the treatment of turkeys of both genders if compared with the control group ($p>0.05$). This is in disagreement with the data of Orda *et al.* (2006) and Mierlita (2014) who reported a significantly higher amount of internal edible parts in chickens fed 5–20% yellow lupines (variety 'Juno') and turkey poults fed 40% white lupines (variety 'Energy').

Table 4 – Effect of different amounts of blue lupine in the diets of turkeys on anatomic carcass dissection data, %

Item		Dressing percentage, mean±SE	Internal edible parts, mean±SE	Abdominal fat, mean±SE
Control group	♂	82.32±0.74	3.39±0.05	0.56±0.24
	♀	85.03±1.04	2.80±0.20	1.53±0.42
Group 1	♂	80.26±2.48	3.73±0.58	0.34±0.08
	♀	82.19±4.21	3.05±0.48	2.80±0.25
Group 2	♂	80.62±0.49	3.77±0.32	0.27±0.07
	♀	84.86±1.42	3.05±0.13	1.62±0.35
Group 3	♂	81.91±1.45	4.46±0.22	0.77±0.22
	♀	84.39±0.64	3.96±0.37	1.37±0.19
Group 4	♂	78.37±0.48*	4.36±0.13	0.62±0.39
	♀	84.93±1.11	3.02±0.22	1.97±0.38
Group 5	♂	81.27±1.07	3.61±0.28	0.29±0.11
	♀	84.63±0.67	2.92±0.34	2.27±0.50

*– $p<0.05$; ±SE – standard error

In our study, there was no correlation determined between the content of abdominal fat and the composition of the feed offered to both trial and control groups of turkeys of both genders. This is in agreement with the findings of Witak *et al.* (2006) in the trial with chickens fed 2.5–15% yellow lupine, Suchy *et al.* (2010) and Orda *et al.* (2006) in the trials with chickens fed, respectively, 8.7–31.0% white lupine (variety 'Amiga') and 5–20% yellow lupine (variety 'Juno'). On the contrary, Mikulski *et al.* (2014) indicated that 18% blue lupine (variety 'Sonet') in the diet of male turkeys had resulted in significantly higher content of abdominal fat. Krawczyk *et al.* (2015) have also found that the content of abdominal fat tended to increase when female turkeys were given 8–24% yellow lupine (variety 'Baryt'). However, Bekric *et al.* (1990) reported that 23% lupines in the diet of chickens had influenced lower abdominal fat percent.

Chemical composition

The dry matter content in the male breast muscles trial groups 1, 2, 3 (Table 5) was from 1.95 to 2.31% lower ($p<0.05$–$p<0.025$), in Group 4 tended to decrease (–1.58%; $p=0.08$) and in Group 5 was statistically insignificantly lower (–1.30 %; $p>0.05$) than that of male turkeys in the control group.

The protein content in male breast muscles in trial (Groups 2 and 3 was from 1.86 to 2.13% lower ($p<0.05$–$p<0.025$), in Groups 1, 4 and 5 tended to decrease from –1.64 to –2.43% ($p=0.06$–$p=0.08$) in comparison with the control group.

Our findings for the dry matter content are contrary to those by Morkunas (2002) who indicated that the male chickens fed the diet containing 10–20% lupines, had from 0.48 to 1.77% higher dry matter content in breast muscles. No other data have

Table 5 – Effect of different amounts of blue lupine in the diets of turkeys on chemical composition of male´s breast muscles

Control group	Group 1	Group 2	Group 3	Group 4	Group 5
Dry matter % mean ±SE					
27.50±0.62	25.21±0.53*	25.19±0.17**	25.55±0.16*	25.92±0.26	26.20±0.54
Protein % mean ±SE					
25.14±0.52	22.71±0.91	23.01±0.29**	23.28±0.14*	23.45±0.37	23.50±0.34
Fat % mean ±SE					
1.29±0.20	1.43±0.39	0.82±0.03	1.16±0.15	0.79±0.04	0.90±0.18
Ash, % mean ±SE					
0.99±0.03	1.05±0.01	0.93±0.09	1.04±0.01	1.04±0.01	0.97±0.01
Tryptophan mg 100 g mean ±SE					
369.01±31.76	350.50±20.74	383.57±9.94	352.43±41.73	370.71±15.57	424.25±43.38
Oxyprolin mg 100 g mean ±SE					
54.21±1.59	55.81±4.52	54.00±0.44	53.37±2.14	53.87±1.84	60.11±2.93
Tryptophan:oxyprolin ratio (protein value index)					
6.81	6.28	7.10	6.60	6.88	7.06

*$p<0.05$; **$p<0.025$; ±SE – standard error

been found regarding the dry matter and protein content in the breast muscles of heavy-type turkeys fed lupines.

In our study, the dry matter and protein content data in the female breast muscle, male and female thigh muscles (Table 6, 7, 8) indicated that diet supplementation with lupines had not affected the above indicators. This is in agreement with the results of Olver (1987) in the study with chickens fed 40% white lupine (variety 'Buttercup') regarding dry matter difference, Suchy *et al.* (2010) regarding protein content difference (from one third to two thirds white lupine in the feed, variety 'Amiga'), Froidmont *et al.* (2004), who found no difference for the above indicators in thigh muscles (30–58% lupines in the feed) and Sitko & Čermak (1998) who indicated no difference for the protein content in breast and thigh muscles with 20% lupine in the feed. Moreover, no difference for the dry matter and protein content in the breast muscles were reported by Krawzcyk *et al.* (2015) in the study with female turkeys fed 8–24% yellow lupine (variety 'Baryt') and Mikulski *et al.* (2014) in the study with male turkeys fed 6–18% blue lupine (variety 'Sonet').

Table 6 – Effect of different amounts of blue lupine in the diets of turkeys on chemical composition of female´s breast muscles

Control group	Group 1	Group 2	Group 3	Group 4	Group 5
Dry matter % mean ±SE					
27.34±0.55	26.62±0.49	27.05±0.53	26.89±0.70	25.98±0.42	27.06±0.21
Protein % mean ±SE					
23.51±0.16	22.69±0.60	23.13±0.30	23.16±0.19	22.97±0.46	23.33±0.23
Fat % mean ±SE					
2.60±0.67	2.74±0.77	2.72±0.20	2.59±0.83	1.91±0.17	2.59±0.15
Ash % mean ±SE					
1.10±0.04	1.12±0.03	1.08±0.02	0.97±0.06	1.03±0.04	1.10±0.03
Tryptophan mg 100 g mean ±SE					
317.52±10.09	329.85±13.95	328.72±15.29	309.31±13.07	295.50±11.94	298.08±3.34
Oxyprolin mg 100 g mean ±SE					
65.55±1.38	52.89±0.13*****	58.15±4.61	57.10±1.19***	53.98±0.49*****	62.03±3.29
Tryptophan:oxyprolin ratio (protein value index)					
4.84	6.24	5.65	5.42	5.48	4.81

***p<0.01; *****p<0.001; ±SE – standard error

In our study, the ash content (Table 7) in the thigh muscles of male turkeys was from 0.05 to 0.07% (p<0.05–p<0.025) and from 0.02 to 0.06% (p>0.05) lower in, respectively, Groups 3 and 5 and Groups 1, 2 and 4 in comparison with the control group.

No significant differences for the ash content were found in the breast muscles of male and female turkeys and in the thigh muscles of female turkeys. This is in agreement with the findings of Suchy *et al.* (2010) who indicated that the ash content in the thigh

Table 7 – Effect of different amounts of blue lupine in the diets of turkeys on chemical composition of males thigh muscles

Control group	Group 1	Group 2	Group 3	Group 4	Group 5
Dry matter % mean ±SE					
25.36±0.80	25.99±0.18	24.51±0.62	26.16±0.37	26.43±1.28	25.78±1.02
Protein % mean ±SE					
21.08±0.74	20.65±0.08	20.10±0.07	20.44±0.14	20.19±0.58	20.44±0.45
Fat % mean ±SE					
3.17±0.34	4.30±0.27	3.33±0.57	4.66±0.48	4.83±1.15	4.29±0.58
Ash % mean ±SE					
1.07±0.01	1.01±0.04	1.05±0.02	1.02±0.00*	1.03±0.01	1.00±0.01**
Tryptophan mg 100 g mean ±SE					
320.56±12.38	298.14±11.56	302.73±11.01	303.22±6.20	275.55±12.30	288.23±21.55
Oxyprolin mg 100 g mean ±SE					
93.85±2.16	96.98±4.37	94.00±4.01	107.11±1.05****	103.53±3.79	88.28±2.37
Tryptophan:oxyprolin ratio (protein value index)					
3.42	3.07	3.22	2.83	2.66	3.26

*p<0.05; **p<0.025; ****p<0.005; ±SE – standard error

muscles of male chickens fed 17.3 to 31.0% lupines was lower, however, than in the breast muscles of the same chickens was significantly higher.

In our study, the ash content in the breast muscles was in agreement with the results of Krawczyk *et al.* (2015) in the trial with turkeys fed from 8 to 24% yellow lupine (variety 'Baryt') and lupine in the feed had no influence on the ash content in the breast muscles.

The differences in our study between genders for the dry matter, protein and ash contents in various muscles do not contradict from the findings of Morkunas (2002) and Nalle (2009) who indicated that feeding birds with leguminous plants might result in different data for different genders.

The oxyprolin content in the breast muscles of female turkeys was from 3.52 to 12.66 mg% lower if compared with the control group and statistically significant difference was found when compared with Groups 1, 3 and 4 ($p<0.01$–$p<0.001$). The protein value index in female muscles (Groups 1–4) was from 0.58 to 1.40 units higher in comparison with the control group.

The oxyprolin content in the thigh muscles of male turkeys (Groups 1–4) was from 0.15 to 13.26 mg% higher in comparison with the control group and the significance was determined when comparing with Group 3 ($p<0.001$) and if compared with Group 4, this indicator tended to increase (+9.68 mg%, $p=0.09$). The protein value index in male thigh muscles was from 0.16 to 0.73 units lower in comparison with the control group.

The differences of the results for the oxyprolin content in different male and female muscles are in agreement with the conclusion by Nalle (2009) that the gender of the bird might influence different meat quality indicators. On the contrary, our data on the oxyprolin content partly in female breast and male thigh muscles contradicts the findings of Barroeta (2007) who noticed that the composition of the feed has no influence on the amino acid content in poultry meat and also do not agree with the results of Leikus *et al.* (2004); Leikus (2006); and Juodka *et al.* (2016) who indicated that the use of lupine or peas in the feed had no effect on the oxyprolin content in meat.

It can be concluded that soybean oil meal replacement with lupine content from 20 to 30% in the diets of turkeys had no influence on the growth rate, dressing percentage, edible parts and abdominal fat content, except for the significantly lower dressing percentage in male turkeys fed 30% lupine and probiotic supplement if compared with a lupine free diet.

The study indicated that lupines in the diet of turkeys had a different effect on the meat quality of different genders. Lupines did not have any negative effect on the meat quality of female turkeys and 30% lupines even improved the protein value index of breast muscles. However, 20–30 and 25–30% lupines in male turkey diets lowered dry matter and protein contents in breast muscles but had no negative influence on the main quality indicators in thigh muscles. The results of the study showed that the negative effect on the male breast muscle quality might be avoided using Bio Plus 2B or allzyme SSF additives in the male diets containing 30 % lupines.

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Table 8 – Effect of different amounts of blue lupine in the diets of turkeys on chemical composition of female´s thigh muscles

Control group	Group 1	Group 2	Group 3	Group 4	Group 5
Dry matter % mean ±SE					
30.26±2.73	28.77±0.33	28.64±0.22	28.58±0.86	28.69±0.43	29.13±0.96
Protein % mean ±SE					
22.10±1.42	20.44±0.19	20.31±0.47	20.64±0.15	20.53±0.19	20.40±0.15
Fat % mean ±SE					
6.59±0.96	6.60±0.80	6.12±0.31	6.36±1.00	6.61±0.40	5.26±0.37
Ash % mean ±SE					
0.92±0.14	0.98±0.02	0.91±0.02	0.89±0.04	0.95±0.02	0.91±0.01
Tryptophan mg 100 g mean ±SE					
304.76±39.42	292.37±33.09	274.89±5.48	289.33±8.38	291.31±10.99	301.17±27.28
Oxyprolin mg 100 g mean ±SE					
99.07±1.71	104.82±5.36	102.99±5.71	100.37±6.61	94.65±10.64	111.51±6.50
Tryptophan:oxyprolin ratio (protein value index)					
3.08	2.79	2.67	2.88	3.08	2.70

±SE – standard error

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