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MEAT QUALITY OF QUAIL FED WITH FEEDSTUFF CONTAINING *NIGELLA SATIVA* SEEDS

Józefa Gardzielewska[1], Danuta Szczerbińska[2], Małgorzata Jakubowska[1], Tadeusz Karamucki[1], Marek Ligocki[2]

[1]Institute of Livestock Product Evaluation
[2]Departament of Poultry Breeding
West Pomeranian University of Technology, Szczecin, Poland

Abstract. The research was carried out on female Pharaoh quails from the 7th to 20th weeks of life, divided into 3 nutrition groups. Group I (control) received standard feedstuff for adult birds. Group II received feedstuff with 3% supplementation of *Nigella sativa* seed, and group III with 5% supplementation. All the feedstuffs used in the experiment were isoprotein and isoenergetic. After the completed experiment 12 females were randomly selected from each group and slaughtered. In the isolated breast and leg muscles the following characteristics were determined: water holding capacity, drip loss, colour, basic chemical composition, fatty acid composition, and sensory attractiveness of meat and broth. The obtained results showed no effect of the supplementation on the basic chemical composition of breast and leg meat, or the content of fatty acids. We observed a favourable effect of 5% supplementation on the colour of meat. We observed a deterioration in the tastiness of the cooked breast muscles and broth made from these muscles. Meat of quails receiving the lower 3% doses of supplementation was more tender.

Key words: fatty acid profile, meat quality, *Nigella sativa* seed, quail

INTRODUCTION

The seeds of *Nigella sativa* are known to have a healing effect due to, among other things, a high concentration of monounsaturated and polyunsaturated acids including linoloic acid (LA), γ linolenic acid (GLA) and oleic acid, which are

Corresponding author – Adres do korespondencji: dr hab. Małgorzata Jakubowska, West Pomeranian University of Technology, Szczecin, Departament of Livestock Product Evaluation, ul. Doktora Judyma 24, 71-466, Szczecin, Poland, e-mail: malgorzata-jakubowska@zut.edu.pl

not synthesized by the human body [Nafez et al. 2009]. This is why attempts are being made to apply *Nigella sativa* seeds in feedstuffs for poultry. Research on the use of these seeds in the nutrition of chickens reared for egg laying has shown that this may result in a low content of cholesterol in the egg yolk [El Bagir et al. 2006, Aydin et al. 2008].

Nasir and Grashorn [2010] have shown that the introduction of these seeds to feedstuffs may increase the slaughter efficiency of chickens, and promote a higher proportion of breast muscle in the chicken carcass. The results by Guler et al. [2006] have shown that *Nigella sativa* seed supplementation in combination with antibiotics contributes to higher gains in body mass for broilers. Also, research conducted by [Toghyani et al. 2010] has shown that *Nigella sativa* supplementation in the feedstuffs of broilers (2 and 4 g per kg) results in higher body mass gains in the 42-day long fattening period, and that this increase depended on the content of seed in the feedstuff. At the same time it was not associated with any deterioration in sensory attractiveness of the obtained meat. In available literature we have found no papers on the influence of *Nigella sativa* seeds on the quality of poultry meat, including quail meat.

Therefore the aim of this paper was to examine the effects of *Nigella sativa* seed supplementation to feedstuff used in quail nutrition on the chemical composition and physicochemical and sensory characteristics of quail meat.

MATERIAL AND METHODS

The research was carried out on female Pharaoh quails. The experiment was conducted from the 7th to 20th weeks of the bird's life. In the control group (group I), birds were given standard feedstuff for adult quails.

In the experimental groups the standard feedstuff was supplemented with *Nigella sativa* seeds in two different doses. In group II the share was 3% and in group III 5%.

After the experiment 12 females were randomly selected from each group and after 12 hours fasting the birds were slaughtered by decapitation with a sharp knife, after previous stunning. After exsanguination, defeathering and gutting, the carcasses were stored until the following day at a temperature of about 6°C. 24 hours after slaughter the breast and leg muscles were isolated from the carcasses and the following determinations were made:

1. The hydrogen ion concentration.
2. Measurement of colour - determined after placing meat samples in measurement dishes and storing them for 20 minutes in a refrigerator at 4°C to

allow oxygenation of myoglobin in the surface layer of the meat. Colour was measured using a MiniScan XE Plus 45/0 with a port hole diameter measuring 31.8 mm adapted to measure the colour of minced meat, using a scale of CIEL*a*b* according to CIE [1976], and the illuminant D65 and standard observer 10°. Calibration of the apparatus was made using black and white reference standards with coordinates X = 78.5, Y = 83.3 and Z = 87.8.

3. Water holding capacity - based on the percentage of free water in meat according to Grau and Hamm [1953] with Pohja and Niinivaara modifications [1957].
4. Basic chemical composition of muscle by AOAC [(2003].
5. Fatty acid composition in breast muscles using gas chromatograph-mass spectrometry (GCMS), "Claus 600" [PN–EN ISO 5508, PN–EN ISO 5509, PN–EN ISO 5555].
6. For the purposes of sensory evaluation was carried out by the placing of muscle samples in 300 ml glass jars and covered with 100 ml of water. The jars were then closed, placed in a hot water bath until reaching a temperature of 85°C inside the muscle, according to the methodology specified by Baryłko-Pikielna et al. [1964]. The sensory characteristics of the meat and broth were evaluated using a 5-point scale, where 1 point meant the worst score, and 5 points the best. This assessment was conducted by a team of five according to specified norms [PN–ISO–4121].
7. Thermal drip by evaluating the difference between the weight of the meat sample before cooking and it was expressed as a percentage of the weight of samples before cooking.

The results were statistically analysed using a univariate analysis of variance. The significance of differences was determined using Duncan's test and Statistica 7.0 software.

RESULTS AND DISCUSSION

The use of *Nigella sativa* seed in the quail feedstuff had no discernable effect on the chemical composition of the breast and leg muscles (Table 1). The obtained results are not consistent with the results carried out on broilers by Shewita and Taha [2011] who showed positive effects of this seed on the content of dry mass and protein in the leg and breast muscles.

The analysis of physicochemical determinations of the breast muscle in the examined quails showed only changes in colour (Table 2). Greater redness (a*) than in the control group was observed in the breast muscle of birds receiving

5% *Nigella sativa* seed in feed (group III). The obtained result does not confirm experimental results on chickens, in which *Nigella sativa* seed showed no effect on the colour of meat [Nasir and Grashorn 2010].

The pH of the quail breast muscle was typical for this meat and ranged from 5.75 to 5.90. A similar range was observed by Daszkiewicz et al. [1998].

Table 1. The chemical composition of breast and leg muscles in quails, %

Tabela 1. Skład chemiczny (%) mięśni piersiowych i nóg przepiórek

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3%	5%
		II	III
Breast muscles – Mięśnie piersiowe			
Dry matter – Sucha masa	27.97 ± 0,51	27.42 ± 0.43	27.60 ± 0.75
Total protein – Białko ogólne	23.91 ± 0,53	23.61 ± 0.47	23.76 ± 0.43
Raw fat – Tłuszcz surowy	2.53 ± 0,83	2.61 ± 0.42	2.60 ± 0.42
Ash – Popiół	1.22 ± 0,14	1.20 ± 0.18	1.24 ± 0.14
Leg muscles – Mięśnie nóg			
Dry matter – Sucha masa	25.93 ± 1.54	25.30 ± 0.84	25.25 ± 0.63
Total protein – Białko ogólne	20.66 ± 1.09	20.38 ± 0.61	20.30 ± 0.66
Raw fat – Tłuszcz surowy	4.25 ± 1.26	3.95 ± 0.77	3.96 ± 1.06
Ash – Popiół	0.96 ± 0.09	0.87 ± 0.18	0.99 ± 0.07

Table 2. Results of the evaluation of physicochemical characteristics of quail breast muscle

Tabela 2. Wyniki oceny cech fizykochemicznych mięśni piersiowych

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3%	5%
		II	III
pH	5.83 ± 0.14	5.90 ± 0.13	5.81 ± 0.05
L*	32.80 ± 2.45	32.60 ± 1.89	33.22 ± 2.15
a*	10.80A ± 0.99	10.32A ± 0.48	12.53B ± 1.79
b*	9.00 ± 1.10	7.99 ± 0.91	9.73 ± 1.49
Free water, % – Woda luźna, %	3.65 ± 0.62	3.33 ± 1.19	3.19 ± 1.67
Thermal drip, % – Wyciek termiczny, %	35.60 ± 3.31	35.96 ± 1.46	37.37 ± 2.99

A, B – highly significantly ($P \leq 0.01$).
A, B – oznaczone różnymi literami różnią się istotnie przy $P \leq 0,01$.

The sensory evaluation of the cooked breast muscles (Table 3) indicated a favourable effect of applied supplementation on the tenderness of muscles in birds receiving lower doses of this seed in their feed (group II) and a negative effect on the palatability of meat of birds receiving a higher dose (group III). In the broth obtained from breast muscles a negative effect of supplementation was observed both in groups II and III (Table 4). The remaining sensory characteristics of the

broth made from breast and leg muscles showed no effect from the applied supplementation. In the performed experiment, we observed no changes in the aroma of the meat. Also, in another experiment on broilers [Toghyani et al. 2010], the use of *Nigella sativa* seed supplementation did not change the flavour of meat.

Table 3. The results of sensory evaluation of cooked breast and leg muscles (in points)

Tabela 3. Wyniki oceny sensorycznej gotowanych mięśni piersiowych i nóg przepiórek (pkt)

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3% II	5% III
Breast muscles – Mięśnie piersiowe			
Flavour – Zapach	5.00 ± 0,00	5.00 ± 0.00	5.00 ± 0.00
Tenderness – Kruchość	4.10A ± 0,45	5.00B ± 0.00	4.00A ± 0.00
Juiciness – Soczystość	3.70 ± 0,84	3.50 ± 0.00	3.40 ± 0.54
Palatability – Smakowitość	4.40A ± 0,37	4.00A ± 0.00	3.20B ± 0.45
Leg muscles – Mięśnie nóg			
Flavour – Zapach	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Tenderness – Kruchość	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Juiciness – Soczystość	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Palatability – Smakowitość	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00

A, B – highly significantly ($P \leq 0.01$).
A, B – oznaczone różnymi literami różnią się istotnie przy $P \leq 0,01$.

Table 4. The results of sensory evaluation of broth cooked from breast and leg muscles (in points)

Tabela 4. Wyniki oceny sensorycznej bulionu z mięśni gotowanych (pkt)

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3% II	5% III
Breast muscles – Mięśnie piersiowe			
Flavour – Zapach	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Tenderness – Kruchość	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Juiciness – Soczystość	4.75 ± 0.30	4.60 ± 0.22	4.60 ± 0.22
Palatability – Smakowitość	4.70A ± 0.89	2.00B ± 0.75	3.00B ± 0.67
Leg muscles – Mięśnie nóg			
Flavour – Zapach	4.50 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Tenderness – Kruchość	5.00 ± 0.00	5.00 ± 0.00	5.00 ± 0.00
Juiciness – Soczystość	4.10 ± 0.35	4.00 ± 0.00	4.20 ± 0.45
Palatability – Smakowitość	4.95 ± 0.33	4.90 ± 0.22	5.00 ± 0.00

A, B – highly significantly ($P \leq 0.01$).
A, B – oznaczone różnymi literami różnią się istotnie przy $P \leq 0,01$.

The composition of fatty acids in the quail meat is presented in Tables 5–8. Regardless of the dosage, in quails receiving the seed supplementation the most dominant saturated acid was palmitic acid C16 : 0 (about 24%), and in unsaturated acids the most dominant were oleic acid C18 : 1 (about 40%) and linoleic acid

C18 : 2 (about 18%). Similar values for quail meat were observed by Tarasewicz et al. [2001] and Genchev et al. [2008].

No effect on the content of fatty acids was observed, regardless of the dose of supplementation. The use of *Nigella sativa* seed did not decrease the level of saturated fatty acids. It is not consistent with the results of an experiment on chickens reared for egg laying [Yalcin et al. 2009] that showed a decrease in the level of saturated fatty acids in egg yolk.

Table 5. Saturated fatty acids (SFA) (% total fatty acids)

Tabela 5. Skład kwasów tłuszczowych nasyconych (% sumy kwasów tłuszczowych)

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3%	5%
		II	III
C 12:0	0.0564 ± 0.00	0.0555 ± 0.00	0.0563 ± 0.00
C 14:0	0.802 ± 0.00	0.798 ± 0.00	0.800 ± 0.00
C 15:0	0.100 ± 0.00	0.101 ± 0.00	0.099 ± 0.00
C 16:0	24.247 ± 0.09	24.205 ± 0.16	24.187 ± 0.15
C 17:0	0.0193 ± 0.00	0.0191 ± 0.00	0.0191 ± 0.00
C 18:0	5.129 ± 0.06	5.125 ± 0.09	5.106 ± 0.06
C 20:0	0.149 ± 0.00	0.150 ± 0.00	0.151 ± 0.00
C 22:0	0.0248 ± 0.00	0.0260 ± 0.00	0.0246 ± 0.00
Σ Saturated fatty acids (SFA) Kwasy tłuszczowe nasycone	30.527 ± 0.13	30.480 ± 0.23	30.443 ± 0.19

Table 6. Monounsaturated fatty acids (MUFA) (% total fatty acids)

Tabela 6. Skład kwasów tłuszczowych jednonienasyconych (MUFA) (% sumy kwasów tłuszczowych)

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3%	5%
		II	III
C 14:1	0.295 ± 0.00	0.292 ± 0.00	0.294 ± 0.01
C16:1c	8.543 ± 0.05	8.551 ± 0.06	8.553 ± 0.04
C16:1 t	0.0303 ± 0.00	0.0300 ± 0.00	0.0303 ± 0.00
C 18:1 n–9 c	39.936 ± 0.12	40.027 ± 0.28	40.058 ± 0.19
C 18:1 n–9 t	0.898 ± 0.00	0.894 ± 0.01	0.896 ± 0.00
C 20:1	0.352 ± 0.00	0.356 ± 0.00	0.354 ± 0.00
C22:1 n–9	0.0984 ± 0.00	0.0974 ± 0.00	0.0984 ± 0.00
Σ Monounsaturated fatty acids (MUFA) Kwasy tłuszczowe jednonienasycone	50.156 ± 0.16	50.247 ± 0.33	50.270 ± 0.21

Table 7. Polyunsaturated fatty acids (PUFA) (% total fatty acids)

Tabela 7. Skład kwasów tłuszczowych wielonienasyconych (PUFA) (% sumy kwasów tłuszczowych)

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3%	5%
		II	III
C 18:2 n–6 c	17.801 ± 0.07	17.757 ± 0.3	17.749 ± 0.05
C 18:3 n–3	0.903 ± 0.01	0.901 ± 0.1	0.905 ± 0.01
C 18:3 n–6	0.0111 ± 0.00	0.0111 ± 0.0	0.0110 ± 0.00
C 20:2 n–6	0.0570 ± 0.00	0.0578 ± 0.00	0.0572 ± 0.00
C 20:3 n–6	0.0644 ± 0.00	0.0644 ± 0.00	0.0643 ± 0.00
C 20:4 n–6	0.284 ± 0.01	0.284 ± 0.00	0.289 ± 0.01
C 20:5 n–3	0.197 ± 0.00	0.193 ± 0.00	0.196 ± 0.01
C 22:5 n–6	0.00213 ± 0.00	0.00213 ± 0.00	0.00213 ± 0.00
C 22:6 n–3	0.00109 ± 0.00	0.00110 ± 0.00	0,00111 ± 0.00
Σ Polyunsaturated fatty acids (PUFA) Kwasy tłuszczowe wielonienasycone	19.321 ± 0.07	19.271 ± 0.13	19.274 ± 0.05

Table 8. The composition of fatty acids, by type

Tabela 8. Skład kwasów tłuszczowych z podziałem na rodzaje

Groups Grupa	I	*Nigella sativa* seeds – Nasiona czarnuszki	
		3%	5%
		II	III
Saturated fatty acids (SFA) Kwasy tłuszczowe nasycone	30.527 ± 0.13	30.480 ± 0.23	30.443 ± 0.19
Monounsaturated fatty acids (MUFA) Kwasy tłuszczowe jednonienasycone	50.156 ± 0.16	50.247 ± 0.33	50.270 ± 0.21
Polyunsaturated fatty acids (PUFA) Kwasy tłuszczowe wielonienasycone	19.321 ± 0.07	19.271 ± 0.13	19.274 ± 0.05
Unsaturated fatty acids UFA Nienasycone kwasy tłuszczowe	69.473 ± 0.13	69.519 ± 0.23	69.544 ± 0.19
PUFA/MUFA	0.28	0.28	0.28
UFA/SFA	2.27	2.28	2.28
PUFA n–6/PUFA n–3	16.55	16.60	16.49

CONCLUSIONS

1. There was no effect of *Nigella sativa* seed (3% and 5%) supplementation on the basic chemical composition of the quail breast and leg muscles.
2. Analysis of physicochemical characteristics showed only greater redness in the group using 5% supplementation. The remaining characteristics showed no effect from the supplementation.

3. Greater doses of *Nigella sativa* seed deteriorated the palatability of the cooked breast meat, and broth made from this meat. Lower doses of this supplementation improved the tenderness of the breast muscles.
4. *Nigella sativa* seed (3% and 5%) supplementation did not have a significant effect on the content of saturated and unsaturated fatty acids.

REFERENCES

AOAC. 2003. Official Methods of Analysis of AOAC International. 17th Ed. Association of the Official Analytical Chemists [AOAC]. Gaithersburg. MD. USA.

Aydin R., Karaman M., Cicek T., Yardibi H. 2008. Black cumin (*Nigella sativa* L.) supplementation into the diet of the laying hen positively influences egg yield parameters, shell quality, and decreases egg cholesterol. Poult. Sci. 87 (12), 2590–2595.

Baryłko-Pikielna N., Kossakowska T., Baldwin Z., 1964. Wybór optymalnej metody przygotowania mięsa wołowego i wieprzowego do oceny sensorycznej [Selection of the optimum method of beef and pork preparation for sensory evaluation]. Rocz. Inst. Przem. Mięs. 1, 111–32 [in Polish].

CIE. Colourimetry, 1976. Official recommendations of the international commission on illumination. Publication CIE Bureau Central de la Commission Internationale De L'Eclairage, Paris.

Daszkiewicz T., Pudyszak K., Meller Z., Mikulski D., 1998. Wpływ żywienia mieszankami o zróżnicowanej wartości pokarmowej na skład chemiczny oraz właściwości fizyko-chemiczne i sensoryczne mięsa przepiórek [The effect of feed mixtures of different nutritive values on the chemical composition and physico-chemical and sensory properties of the quail meat]. Zesz. Nauk. PTZ. Chów i hodowla drobiu 36, 313–317 [in Polish].

El Bagir, N.M. Hama, A.Y., Hamed, R.M., Abd El Rahim, A.G., Beynen, A.C., 2006. Lipid composition of egg yolk and serum in laying hens fed diets containing black cumin (*Nigella sativa*). Int. J. Poult. Sci. Vol. 5, Issue 6, 574–578.

Genchev A., Mihaylova G., Rybarski S., Pavlov A., Kabakchiev M., 2008. Meat quality and composition in Japanese quails. Trakia J. Sci. 6 (4), 72–82.

Grau R., Hamm R., 1953. Eine einfache Methode zur Bestimmung der Wasserbindung im Muskel. Naturwissenschaften 40, 29–30.

Guler T., Dalkiliç B., Ertas O.N., Çiftçi M., 2006. The effect of dietary black cumin seeds (*Nigella sativa* L.) on the performance of broilers. Asian-Australasian J. An. Sci. 19 (3), 425–430.

Nafez A. Al-Beitawai, Safaa S. El-Ghasein, Abdullah H. Nofal., 2009. Replacing bacitracin methylene disalicylate by crushed *Nigella sativa* seeds in broiler rations and its effects on growth, blood constituents and immunity. Livest. Prod. Sci. 125 (2), 304–307.

Nasir Z., Grashorn, M.A., 2010. Effects of Echinacea purpurea and *Nigella sativa* supplementation on broiler performance, carcass and meat quality. J. An. Feed Sci. 19 (1), 93–103.

PN-EN ISO 5508. 1996. Analiza estrów metylowych kwasów tłuszczowych metodą chromatografii gazowej [Analysis by gas chromatography of methyl esters of fatty acids] [in Polish].

PN-EN ISO 5509. 2001. Oleje i tłuszcze roślinne oraz zwierzęce. Przygotowanie estrów metylowych kwasów tłuszczowych [Animal and vegetable fats and oils – preparation of methyl esters of fatty acids] [in Polish].

PN-EN ISO 5555. 2002. Oleje i tłuszcze roślinne oraz zwierzęce. Pobieranie próbek. [Animal and vegetable fats and oils. Sampling] [in Polish].

PN-ISO-4121.1998. Analiza sensoryczna. Metodologia. [Sensory analysis. Methodology. Evaluation of foodstuffs using calibration methods] [in Polish].

Pohja M.S., Niinivaara F.P., 1957. Die Bestimmung der Wasserbindung des Fleisches mittels der Konstantdrückmethode. Fleischwirtschaft 9, 193–195.

Shewita R.S., Taha A. E., 2011. Effect of Dietary Supplementation of Different Levels of Black Seed (*Nigella sativa* L.) on Growth Performance, Immunological, Hematological and Carcass Parameters of Broiler Chicks. Word Academy of Science, Engineering and Technology 77, 788–794.

Tarasewicz Z., Piech M., Szczerbińska , Dańczak A., Romaniszyn K., 2001. Wpływ owsa nieoplewionego na użytkowość rzeźną młodych przepiórek japońskich [Effect of naked Atos on slaughter efficiency of young japanese quails]. Zesz. Nauk. PTZ 57, 195–205 [in Polish].

Toghyani M., Toghyani M., Gheisari A., Ghalamkari G., Mohammadrezaei M., 2010. Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of black seed (*Nigella sativa*) and peppermint (Mentha piperita). Livest. Prod. Sci. 129 (1–3), 173–178.

Yalçin S., Yalçin S., Erol H., Buğdayci K.E., Özsoy B., Çakir S., 2009. Effects of dietary black cumin seed (*Nigella sativa* L.) on performance, egg traits, egg cholesterol content and egg yolk fatty acid composition in laying hens. J. Sci. Food Agric. 89 (10), 1737–1742.

KSZTAŁTOWANIE SIĘ CECH JAKOŚCIOWYCH MIĘSA PRZEPIÓREK ŻYWIONYCH PASZĄ Z UDZIAŁEM NASION CZARNUSZKI SIEWNEJ (*NIGELLA SATIVA* L.)

Streszczenie. Badania przeprowadzono na przepiórkach samicach rasy Faraon w okresie od 7. do 20. tygodnia życia podzielonych na trzy grupy żywieniowe: grupę I (grupa kontrolna) otrzymującą paszę standardową przeznaczoną dla dorosłych ptaków, w grupie II mieszanka paszowa zawierała 3% i w grupie III zawierała 5% nasion czarnuszki siewnej. Wszystkie mieszanki paszowe użyte w doświadczeniu były izobiałkowe i izoenergetyczne. Po zakończonym doświadczeniu wybrano po 12 samic z każdej grupy

i poddano ubojowi. W wydzielonych mięśniach piersiowych i nóg określano wodochłonność, wyciek termiczny, barwę, podstawowy skład chemiczny, skład kwasów tłuszczowych i atrakcyjność sensoryczną mięśni oraz bulionu. Na podstawie przeprowadzonych badań nie stwierdzono wpływu podanych nasion w paszy na podstawowy skład chemiczny mięśni piersiowych i nóg oraz zawartość kwasów tłuszczowych. Zanotowano korzystny wpływ dodatku 5% czarnuszki na barwę mięsa. Stwierdzono pogorszenie smakowitości gotowanych mięśni piersiowych i bulionu z tych mięśni, natomiast lepszą kruchość mięśni piersiowych odnotowano u ptaków otrzymujących mniejsze dawki nasion czarnuszki.

Słowa kluczowe: mięso, nasiona czarnuszki, profil kwasów tłuszczowych, przepiórki

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