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THE EFFECT OF FLAX SEEDS ADDITION IN NUTRITION OF QUAILS ON THE QUALITY OF CARCASS AND MEAT

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ABSTRACT

The study was performed on 6-week-old Pharaoh quails. The birds were divided into 2 feeding groups: the control, fed with the standard starter and finisher fodder, and the experimental one, fed with the fodder mixtures containing 4% fragmented flax seeds. After the experiment was completed, the birds were slaughtered and a simplified slaughter analysis was performed. From each carcass the pectoral and leg muscles, liver, stomach, heart, and fat were obtained. The pectoral muscles were used to determine the basic chemical composition and for the sensory assessment of the colour, aroma, tenderness and juiciness of the cooked meat was performed. The study allowed to find that the quails from the experimental group were characterized by a significantly lower carcass fatness, and in the remaining parameters of slaughter analysis, no differences between the control and experimental group were found. The use of flax seeds in quails nutrition had no effect on the chemical composition of pectoral muscles, only a tendency to increase the protein, dry weight and ash content, and a decrease in the intramuscular fat content were observed. The sensory evaluation showed that in the meat of birds receiving flax seeds deviations in colour, juiciness and palatability may occur.

Key words: carcass quality, sensory evaluation, chemical composition, quails

INTRODUCTION

In animal farming, great attention is paid to the improvement of production effects by improving the concentration of energy in feed rations for livestock. The energy feed additives used in animal nutrition include oilseeds, oilcake, pomace and vegetable oils [Gubała 2004, Klebaniuk et al. 2012].

Flax is one of such oily plants that in both forms: fragmented and in seeds, is characterized by many health properties. Flax seeds contain proteins, sterols, organic acids, zinc, iron, magnesium, enzymes, and unsaturated fatty acids [Borowiec et al. 2005].

By using flax seeds or flax oil, as well as other forms of fat in animal nutrition, we can positively affect their productivity, improve the nutritional value of meat or modify the fatty acid profile in the fat of animal products, improving their quality [Horoszewicz et al. 2010, Jakubowska et al. 2012, Konca et al. 2014, Kawęcka et al. 2016, Makała 2019].

The studies on the composition and quality of meat were carried out with the use of oilseeds or other forms of flax, on various species of poultry. It has been observed that the addition of an oil rich in polyunsaturated fatty acids (PUFA) to the fodder instead of the saturated SFAs reduces the amount of fat tissue in broilers, especially in abdominal fat [Pinchasov and Nir 1992, Zollitsch et al. 1997, Sanz et al. 1999, Sanz et al. 2000, Crespo and Esteve-Garcia 2002, Newman et al. 2002, Villaverde et al. 2005]. The content of fatty acids in the diet also affects the composition of adipose tissue and intramuscular fat in poultry. An enrichment of muscle tissue in fat containing the unsaturated alpha-linolenic acid (C18: 3 n-3) and linoleic acid (C18: 2 n-6) improves the dietary qualities of meat and plays a pro-health effect [Migdał et al. 2008].

However, apart from its pro-health properties, the nutritional and sensory properties of meat are equally important, determining its acceptance by the consumer.

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Lopez-Ferrer et al. [2001], Jamroz [2004] and Jakubowska et al. [2012] found that with an increased content of polyunsaturated acids in the fat of meat of slaughter animals, its sensory attractiveness, especially taste, smell and texture, may deteriorate.

Therefore, the aim of our study was to determine whether the addition of 4% fragmented flax to fodder will have an impact on features like sensory characteristics of cooked meat, its chemical composition and slaughter value of quails.

MATERIAL AND METHODS

All the applied procedures were performed according to the guidelines for the care and use of research animals and were approved by the Local Ethics Committee on Animal Experimentation (West Pomeranian University of Technology in Szczecin, resolution number 30/2010, Szczecin, PL).

The study included 64 Japanese Pharaoh quail with equal proportion of sexes. The birds were reared up to the age of 6 weeks. The birds were fed with the starter fodder (EN. MET. 12 MJ, BO 24%) in the first rearing period, and then with the finisher fodder (EN.MET. 11,6 MJ, 20% B.O.) in the second period. In the first rearing period, the birds were divided into 2 groups: control and experimental (32 individuals each), where the experimental group received fodder with 4% addition of fragmented flax throughout the rearing period. Six-week-old Japanese Pharaoh quails were slaughtered (after 12h of ante-mortem fasting) by decapitation with a sharp knife. After bleeding, plucking, and evisceration, the carcasses were kept in a refrigerator at a temperature of about 4°C for 24 hours. The cooled carcasses were weighed and dissected according to the recommendations of Ziołecki and Doruchowski [1989]. From each carcass, pectoral and leg muscles, heart, liver and fat were collected and weighed with the laboratory WPS 600/C/1 scales (Radwag) to the nearest 0.01 g.

The assessment of chemical composition was based on percentage determination of basic chemical components levels: total water, total protein, fat, and ash:

- total water content was calculated basing on the determination of dry matter content, by drying the sample at 105°C, after the denaturation of proteins with 96% ethyl alcohol [AOAC 2003];
- total protein content was determined by the Kjeldahl method [AOAC 2003]
- intramuscular fat content was determined by the Soxhlet extraction [AOAC 2003]
- ash content was determined by combustion analysis according to the Polish Standard PN-89/A-82115 [PN 1989].

The sensory evaluation concerned the pectoral muscles. It was performed by a five-person team tested in terms of sensory sensitivity in accordance with the Polish Standard PN-ISO-4121 [PN-ISO 1998]. The meat was cooked to the internal temperature of 85°C in accordance with the method given by Baryłko-Pikielna et al. [1964], in twice the weight of water in relation to the weight of meat. The following parameters of meat were assessed: color, smell, flavor and tenderness. The evaluation was made on a five-point scale, where the highest score was 5 points and the lowest 1 point (Table 1).

The obtained results were statistically compiled with the Statistica 12.5 PL software. One-way ANOVA was used to calculate the influence of flax on selected factors of the slaughter value, chemical composition of the pectoral muscles and sensory evaluation of meat from the quail pectoral muscles. The results were assessed for differences using Duncan's test with a significance level of $P \leq 0.05$. Normality of distribution was tested using the Shapiro-Wilk test.

Table 1. Sensory evaluation of cooked meat in points

Tabela 1. Ocena sensoryczna gotowanego mięsa w punktach

Score Punkty	Colour Barwa	Aroma Zapach	Tenderness Kruchość	Juiciness Soczystość	Flavour Smakowitość
1	inappropriate, undesirable, too light or too dark niewłaściwa, niepożądana, zbyt jasna lub zbyt ciemna	extremely undesirable, strange wybitnie niepożądany, obcy	extremelly tough, very hard to bite bardzo twarde, bardzo trudne do pogryzienia	very dry, chipped bardzo suche, wiórowate	extremely undesirable, strange wybitnie niepożądana, obca
2	right, not desirable właściwa, mało pożądana	undesirable niepożądany	tender meat, hard to bite twarde, trudne do pogryzienia,	dry suche	undesirable niepożądana
3	proper właściwa	proper właściwy	pretty brittle dość kruche	light juicy lekko soczyste	proper, quite desirable właściwa, lekko pożądana
4	desirable pożądana	desirable pożądany	fragille kruche	juicy soczyste	desirable pożądana
5	highly desirable wysoce pożądana	very desirable wybitnie pożądany	extreme tenderness and extremely brittle bardzo kruche	extremely juicy wybitnie soczyste	highly desirable wysoce pożądana

RESULTS

Slaughter value of quails

Table 2 presents the results of quails slaughter value evaluation. Birds from the experimental group, where fragmented flax seeds were added to the fodder, were characterized by a higher body weight (183.27 g) and lower carcass weight (114.00 g), compared to the control group (180.36; 115.20 g, respectively). The differences were however not confirmed statistically at $P \leq 0.05$. In our experiment we noted that the 4% addition of flax to the fodder did not significantly increase the slaughter efficiency index and the weight of the liver, heart and stomach, and the mean values for both groups were very similar (Table 2). In turn, a statistically significant decrease in fat content was found in quails from the experimental group. The amount of carcass fat for the experimental group was 3.26 g and for the control group 5.64 g. There was a trend towards the greater pectoral muscle mass in the experimental group. The weight of the pectoral muscles for the control group was 38.22 g, and for the experimental group 38.85 g. However, the quails from the experimental group were characterized by a greater mass of the femoral muscles (26.45 g) compared to the control group (25.32 g), but this was not a statistically significant difference.

Chemical composition of pectoral muscles

Table 3 shows the results of analysis of pectoral muscle chemical composition. The average amount of dry matter in the quail meat ranged from 25.86% to 26.07%. The content of intramuscular fat in the examined samples ranged from 1.3% to 1.70%, and the mean total protein content from 21.84% to 21.99%. The average ash values ranged from 1.36% to 1.43%. In the experimental group of birds we found a trend to a higher protein, ash and dry weight content in the pectoral muscles. There was a slight decrease in the fat content in the muscles of birds fed with 4% flax, compared to the control group. The addition of flax to the fodder played no significant ($P \leq 0.05$) role for the chemical composition of the quail pectoral muscles.

Sensory analysis

In Table 4 we present the mean values for the sensory analysis of cooked quail pectoral muscles. The deterioration of colour of the cooked meat was observed in the experimental group of quails (3.00 points) compared to the control group (3.46 points). The addition of flax to the fodder improved however the aroma of cooked meat, and the obtained scores were 4.88 points for the control group, and 5.00 points for the experimental group. The assessed meat was characterized by the correct tenderness. Boiled pectoral muscles in both groups obtained high scores: 4.89 points (control group) and 4.82 points (experimental group). A reduction in juiciness and palatability of meat was observed in the group of quails with 4% addition of flax seeds (Table 4). Samples from the control group of quails were characterized by better juiciness and flavor (respectively: 3.07 points; 4.91; points) compared to the experimental group of quails (respectively: 2.82 points; 4.60 points). No statistical relationship was found in the tested sensory characteristics of cooked quail meat at $P \leq 0.05$.

DISCUSSION

Slaughter value

The use of feed mixtures with a high concentration of energy in the nutrition of poultry ensures a fast growth rate, health, low fat content and good carcass and meat quality

Table 2. Results of slaughter analysis of quails

Tabela 2. Wyniki analizy rzeźnej przepiórek

Traits – Cechy	Groups – Grupy			
	control – kontrolna		treatment – eksperymentalna	
	$\bar{x}$	SD	$\bar{x}$	SD
Body weight, g – Masa żywa, g	180.36	12.36	183.27	18.70
Carcass weight, g – Masa tuszki, g	115.20	9.23	114.00	8.57
Carcass dressing yield percentage, % – Wskaźnik wydajności rzeźnej, %	63.98	2.19	63.14	7.50
Liver weight, g – Masa wątroby, g	4.00	0.78	3.89	0.80
Heart weight, g – Masa serca, g	1.76	1.45	1.72	0.19
Stomach weight, g – Masa żołądka, g	4.96	0.85	5.00	0.92
Fatness, g – Otłuszczenie, g	5.64*	2.60	3.26*	1.60
Breast muscle weight, g – Masa mięśni piersiowych, g	38.22	4.83	38.85	4.80
Leg muscle weight, g – Masa mięśni udowych, g	25.32	2.80	26.45	2.83

*Significance of differences at $P \leq 0.05$.
*Różnice istotne na poziomie $P \leq 0{,}05$.

Table 3. The chemical composition of breast muscles in quails, %

Tabela 3. Skład chemiczny mięśni piersiowych przepiórek, %

Traits – Cechy	Groups – Grupy			
	control – kontrolna		treatment – eksperymentalna	
	$\bar{x}$	SD	$\bar{x}$	SD
Dry matter – Sucha masa	25.86	0.20	26.07	0.63
Ash – Popiół	1.36	0.22	1.43	0.08
Total protein – Białko ogólne	21.84	0.82	21.99	0.33
Intramuscular fat – Tłuszcz śródmięśniowy	1.70	0.60	1.36	0.40
Dry matter – Sucha masa	25.86	0.20	26.07	0.63

Table 4. The results of sensory evaluation of cooked breast musles (in points)

Tabela 4. Wyniki oceny sensorycznej gotowanych mięśni piersiowych (w punktach)

Traits – Cechy	Groups – Grupy			
	control – kontrolna		treatment – eksperymentalna	
	$\bar{x}$	SD	$\bar{x}$	SD
Colour – Barwa	3.46	0.80	3.00	0.00
Aroma – Zapach	4.88	0.21	5.00	0.00
Tenderness – Kruchość	4.89	0.21	4.82	0.30
Juiciness – Soczystość	3.07	0.00	2.82	0.27
Palatalibity – Smakowitość	4.91	0.26	4.52	0.80

[Osek et al. 2008, Makała 2019]. In this experiment, the slaughter analysis showed no effect of 4% addition of flax seeds to the fodder on the of slaughter value parameters in quails. The only effect of the addition was the reduction in fatness of carcasses. In the remaining features of the slaughter value, a tendency was observed towards a higher body weight and a greater share of pectoral and femoral muscles in the carcass. The results obtained in this work are confirmed by the results of the nutritional research of Grześkowiak et al. [2005]. The use of 5% and 7.5% addition of linseed oil for pig fodder did not affect most of the parameters of pig carcasses slaughter value, only a reduction in subcutaneous fat content was noted. Also, Pietras et al. [2000] did not observe any effects on the production effectiveness of rape seeds, flax seeds, rape seed oil and flax oil used in the diet of broiler chickens. In other studies, Makała [2019] found no relationship between the increase in body weight gain and the weight of pectoral and femoral muscles in carcass and the use of 7% addition of crushed flax seeds in the diet of broiler chickens. Jakubowska et al. [2012] showed that the use of flax seeds in nutrition of quails did not increase the share of pectoral and femoral muscles in carcasses. The lack of visible production effects after the use of 4% flax seed additive in this experiment may be the result of an inappropriate balance of the food ration. The content of energy in the diet is the main factor regulating feed intake in poultry. According to Blanch et al. [1996] fats and oils are the most concentrated sources of energy, but their quantity and quality affects the availability of metabolic energy of the entire feed.

Chemical composition

The addition of flax seeds to the feed in quail nutrition did not affect the chemical composition of the pectoral muscles, which is consistent with the research by Jakubowska et al. [2012]. Malczyk [2001], using the linseed oil and flax seeds in the diet of broiler chickens, also did not notice effect of these additives on the chemical composition of meat. Also Baranowski et al. [2007], in a feeding experiment performed in rams, did not show any effect of flax addition on the chemical composition of the longissimus muscle. On the other hand, a beneficial effect of the flax seeds on the chemical composition of meat was proved in an experiment conducted on goat lings by Pieniak-Lendzion et al. [2006]. In the experiment, a 10% addition of flax seeds significantly influenced the dry matter content and the fat content in carcasses. Additionally, the content of fatty acids in meat fat has changed. In the studies by Borys and Borys [2005], the use of fragmented oilseeds in the lambs diet increased the content of intramuscular fat.

In this experiment, we noticed a tendency to increase the content of protein, ash and dry weight in the pectoral muscles of quail, as a result of the 4% flax seeds addition to the fodder (Table 3). There was also a slight decrease in fat content in the pectoral muscles of experimental birds

compared to the control group. It should be emphasized that a decrease in carcass fat and in amount of intramuscular fat of quail pectoral muscles is good news for poultry farmers, because consumers mainly look for dietary meat, which includes lean, and not fatty products.

Sensory analysis

As it is known, apart from the health-promoting properties, flax seeds may show also the adverse effects due to the content of cyanogenic glycosides, trypsin and inhibitors of phytic acid. The introduction of flax seeds as a fodder additive may reduce the physicochemical and sensory properties of meat, which in turn may affect its acceptance by the consumer [Morrissey et al. 1998]. In this study, no significant effect on the sensory characteristics of quail meat fed with flax seeds addition was shown. Instead, we noted that the cooked meat was characterized by excellent tenderness and the desired aroma, and the obtained scores reached the maximum values (Table 4). On the other hand, we observed a negative effect of the flax seeds used in the diet on such features of cooked meat as colour, juiciness and palatability. Our observations are confirmed in the report of Jakubowska et al. [2012, 2013] and Gardzielewska et al. [2012], where the taste and juiciness of cooked meat deteriorated after the use of flax seeds, amaranth and black cumin in the quail diet.

When using flax seeds in the diet of birds, attention should be paid to the dose, as in our research the addition of 4% of flax seeds worsened the color and juiciness of cooked meat and reduced its taste.

CONCLUSIONS

1. Carcasses of quails from the experimental group contained significantly less fat than the obtained in control group; in the remaining parameters of slaughter analysis, no differences were found between the control and experimental groups.
2. The use of flax seeds in nutrition of quails did not affect the chemical composition of pectoral muscles, only a trend to a higher protein, dry weight and ash content, and a decrease in the intramuscular fat content were observed.
3. The use of flax seeds in quails nutrition did not affect the sensory features of cooked meat, only a deterioration of features as juiciness, colour and palatability was observed.

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WPŁYW DODATKU NASION LNU W ŻYWIENIU PRZEPIÓREK NA JAKOŚĆ TUSZY I MIĘSA

STRESZCZENIE

Badanie przeprowadzono na 6-tygodniowych przepiórkach. Ptaki podzielono na 2 grupy żywieniowe: kontrolną, karmioną standardową paszą starterową i tuczniczą, oraz eksperymentalną, karmioną mieszankami paszowymi zawierającymi 4% rozdrobnionych nasion lnu. Po zakończeniu eksperymentu ptaki poddano ubojowi i przeprowadzono uproszczoną analizę uboju. Z każdej tuszy pobierano mięśnie piersiowe i nóg, wątrobę, żołądek, serce i tłuszcz. Na podstawie mięśni piersiowych określono podstawowy skład chemiczny oraz dokonano oceny sensorycznej barwy, zapachu, kruchości i soczystości gotowanego mięsa. Badania pozwoliły stwierdzić, że przepiórki z grupy doświadczalnej charakteryzowały się istotnie mniejszym otłuszczeniem tusz, a w pozostałych parametrach analizy rzeźnej nie stwierdzono różnic między grupą kontrolną a doświadczalną. Stosowanie nasion lnu w żywieniu przepiórek nie miało wpływu na skład chemiczny mięśni piersiowych, obserwowano jedynie tendencję do zwiększania zawartości białka, suchej masy i popiołu oraz spadek zawartości tłuszczu śródmięśniowego. Ocena sensoryczna wykazała, że w mięsie ptaków otrzymujących nasiona lnu mogą występować odchylenia w kolorze, soczystości i smakowitości.

Słowa kluczowe: jakość tuszy, ocena sensoryczna, skład chemiczny, przepiórki

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