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EFFICIENCY OF FEEDING LINSEED TO HERITAGE BREED HENS

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Abstract

The objective of the study was to determine the effect of feeding linseed diets to six heritage breeds/lines of hens on their productivity and egg quality. Subjects were hens of the breeds/lines included in the genetic resources conservation programme, i.e. Greenleg Partridge (Z-11), Yellowleg Partridge (Ż-33), Rhode Island Red (R-11), Sussex (S-66), and Leghorn (lines H-22 and G-99). Layers of each line/breed (180 birds each) were assigned to 2 feeding groups: control (K), which received standard complete diet, and experimental (L), which received a diet supplemented with 10% linseed (Opal variety). Each group consisted of 4 replications. The 10% linseed diet used in the nutrition of heritage breed hens had a positive effect on production results and most physical characteristics important for the consumer such as egg weight, yolk colour, and shell breaking strength. Breed/line had a significant effect on all egg quality traits except breaking strength, which shows that the analysed hens are characterized by biodiversity.

Key words: laying hens, biodiversity, feeding, linseed, egg quality

Traditional linseed varieties are characterized by a high content of fat, including linolenic acid (LNA; $C_{18:3}$ *n-3*); when used in feeding animals, especially poultry, they make it possible to obtain products with functional food properties. The use of linseed or linseed oil in diets of laying hens representing high-producing commercial lines enriches the eggs with unsaturated fatty acids (*n-3* PUFA), mainly LNA, as well as eicosapentaenoic (EPA; $C_{22:5}$) and docosahexaenoic acids (DHA; $C_{22:6}$) formed from LNA (Botsoglou et al., 1998; Bean and Leeson, 2003; Sosin et al., 2006). In studies aimed at enriching eggs, it is necessary to determine if the introduction of acid sources will reduce productivity or adversely affect physical characteristics of eggs. A study with ISA Brown hens (Połtowicz and Wężyk, 2005) revealed that linseed supplemented to layer diets has a favourable effect on yolk colour while slightly reducing its cholesterol content. All physical characteristics of eggs were improved as a result of adding linseed to quail diets (Hazim et al., 2010). However, few studies in this area have investigated heritage breed hens, which are characterized by low egg production, have not been selected for production traits for many years, and are kept in small populations without any infusion of foreign blood and in keeping with the current conservation programme.

In Poland, most of the 19 breeds/lines of laying hens covered by the conservation programme were included by FAO in the list of the protected world genetic resources together with their detailed characteristics (World Watch List, FAO, 2000). The conservation programme covers not only old indigenous breeds of hens: Greenleg Partridge (lines Z-11 and Zk), Yellowleg Partridge (Ż-33) and Polbar (Pb), but also imported populations: Rhode Island Red (lines R-11, K-22, K-44 and K-66), Rhode Island White (A-33, A-22 and A-88), Sussex (S-66), Leghorn (G-99, H-22 and H-33), New Hampshire (N-11), Barred Rock (WJ-44 and P-11) and Barred Plymouth Rock (D-11), which over several dozen years have perfectly adapted to local environmental conditions and play an important role in Polish breeding. Different breeds and lines of hens vary considerably in performance, physical characteristics, and chemical composition of eggs (Krawczyk, 2009), which leads to the conclusion that feeding linseed to different layer genotypes will have different effects on egg quality traits. The objective of this study was to determine the effect of feeding linseed diets (100 g/kg diet) to six heritage breeds/lines of hens on their productivity and egg quality.

Material and methods

The experiment was conducted at the Experimental Station of the National Research Institute of Animal Production in Chorzelów, Poland. Subjects were hens of six breeds/lines included in the genetic resources conservation programme, i.e. Greenleg Partridge (Z-11), Yellowleg Partridge (Ż-33), Rhode Island Red (R-11), Sussex (S-66), and Leghorn (lines H-22 and G-99). Layers of each line/breed (180 birds each) were assigned to 2 feeding groups: control (K), which received standard complete diet, and experimental (L), which received a diet supplemented with 10% linseed (brown-seeded linseed variety Opal). Each group consisted of 4 replications. The experiment was conducted from 37 to 52 weeks of age during the winter-spring period (10 December–9 April). Layers were maintained on litter under standard climatic conditions and fed *ad libitum* in groups using a feed line, with constant access to water.

Chemical analyses of feeds and eggs

Egg production was recorded daily in subgroups, and feed intake was calculated as a mean from 4 weeks. In the last period of the experiment, i.e. at 52 weeks of age, 30 eggs were randomly collected from each layer group and evaluated using EQM equipment (Egg Quality Measurements) for egg and shell quality traits such as egg weight, shell strength and thickness, height of thick albumen, Haugh units, yolk weight and colour, and frequency of meat and blood spots. Shell strength [N] was determined with an Egg Crusher instrument. Basic chemical composition of the complete diets, presented in Table 1, was determined using standard methods (AOAC, 1997).

The data on egg quality were subjected to two-way analysis of variance using the GLM procedure of the SAS Enterprise Guide 9.1 (2002), with genotype and feeding as the main factors. Significant differences between the means were determined with Duncan's multiple range test. Significance of the genotype × feeding interaction was determined.

Results

The complete diets had similar levels of protein (166±1 g/kg) but different energy values (11.1 vs. 11.66 MJ/kg) resulting from the higher content of fat in the linseed diet (DJL) (23 vs. 57 g/kg) (Table 1). The addition of linseed to the diets of all hen breeds/lines except S-66 significantly improved their productivity (Table 2). In the experimental groups, higher egg production (by 7% on average) and lower feed intake (by 17.8 g/egg) were obtained. Mortality in both groups did not exceed 0.6%.

Table 1. Ingredient and chemical composition of the complete diets

Item	DJK[1]	DJL[2]
Ingredient composition (g/kg)		
wheat	300	260
maize	260	240
barley	80	80
wheat bran	40	40
soybean meal	140	100
linseed		100
concentrate (CP 31%, ME 7.0 MJ/kg)[3]	94	94
ground limestone	80	80
feed phosphate	3	3
fodder salt	3	3
Chemical composition		
ME, MJ/kg	11.1	11.7
crude protein (%)	16.5	16.7
ether extract (%)	2.3	5.7

[1] control diet; [2] experimental diet with linseed; [3] protein-mineral concentrate per kg diet; g: lysinę 1.9; met + cys 1.12; threonine 1.22; tryptophan 0.4; Ca 11.2; P 0.85; Na 0.5; IU: vit. A 3760; vit. D_3 940; mg: vit. E 23.5; vit. K 0.75; vit. B_1 0.75; vit. B_2 2.26; vit. B_6 1.5; vit. B_{12} 0.0075; pantothenic acid 4.7; folic acid 0.38.; nicotinic acid 14.1; choline chloride 141; Fe 14.1; Zn 29; Mn 23.5; Cu 2.6; I 0.56; Se 0.09; Co 0.09; lutein 1.5; canthaxantin 0.94.

Table 2. Effect of adding linseed to the diets of heritage breed hens on productivity and physical characteristics of eggs

Item	Breed						Feeding group		SEM	P		
	G99	H22	R11	S66	Z11	Ż33	K	L		breed	feeding group	breed × group
Feed intake (g/bird)	121	120	121	121	121	120	120	121	0.22	ns	ns	ns
Feed conversion (g/egg)	172	188	194	210	205	180	201	183	3.32	***	***	*
Egg production (%)	70.5	64.5	62.8	58.1	60.9	67.8	60.7	67.1	1.08	***	***	ns
Egg weight (g)	60.7	62.7	57.8	55.5	55.9	55.6	57.3	58.8	0.28	***	**	*
Shell colour (pts)	80.7	79.8	47.9	49.1	71.0	63.9	65.09	65.73	0.82	***	ns	ns
Albumen height (mm)	6.11	7.04	7.56	5.84	6.05	5.84	6.40	6.41	0.07	***	ns	ns
Haugh units	76.6	82.3	86.9	76.6	78.0	76.3	79.7	79.3	0.46	***	ns	ns
Yolk colour (Roche)	6.84	6.3 C	7.78	6.64	7.28	6.88	5.34	8.57	0.14	**	***	ns
Yolk weight (g)	16.6	17.1	17.4	16.1	16.1	17.4	16.6	17.0	0.07	***	**	***
Blood spots (%)	2.0	0.0	8.0	14.0	2.0	4.0	8.0	2.0				
Meat spots (%)	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0				
Shell thickness (μm)	350	350	330	340	340	320	340	340	1.90	***	ns	ns
Shell weight (g)	6.05	6.34	5.65	5.43	5.54	5.38	5.63	5.83	0.04	***	**	*
Shell density (mg/cm²)	77.3	80.9	74.5	72.7	74.8	72.4	74.7	76.1	0.45	***	ns	ns
Breaking strength (N)	34.7	33.9	31.4	30.2	31.5	32.3	31.0	33.6	0.59	ns	*	ns

G99 – Leghorn, H22 – Leghorn, R11 – Rhode Island Red, S-66 – Sussex, Ż33 – Yellowleg Partridge, Z-11 – Greenleg Partridge; C – control group; L – linseed group; ns – non significant; * P<0.05; ** P<0.01; *** P<0.001.

Breed/line had a statistically significant effect on all egg quality traits except shell breaking strength. The addition of dietary linseed in the experimental groups had a significant effect only on some of these traits.

Mean egg weight depended on the breed ($P \leq 0.001$) and feeding ($P \leq 0.01$) and was 1.53 g higher in the experimental groups compared to the mean value in the control groups (58.81 vs. 57.28). Heaviest eggs were laid by Leghorn hens (H-22) and lightest by Sussex hens (S-66). The same relationship was noted for yolk weight, but in this case Rhode Island Red hens (R-11) produced eggs with the largest yolks and Greenleg Partridge hens (Z-11) laid eggs with the smallest yolks (17.37 g vs. 16.07 g).

Mean albumen height was 6.41±0.56 mm and Haugh units exceeded 79. Feeding had no statistically significant ($P > 0.05$) effect on this trait in contrast to hen breed/line, which had a highly significant ($P \leq 0.01$) effect, with best results obtained by the eggs from R-11 hens and poorest by the eggs from Yellowleg Partridge (Ż-33) and Sussex hens (S-66).

Eggs produced by hens receiving the linseed diet were characterized by more intensive yolk colour ($P < 0.001$), which was an average of 3.23 points higher on the Roche scale in the experimental groups compared to the control groups of all hen breeds/lines (8.57 vs. 5.34). Blood and meat spots in egg yolks did not increase beyond normal levels except a slightly higher number of blood spots in the egg yolks of S-66 layers from both groups.

The dietary inclusion of linseed in the experimental groups significantly increased shell weight (by 0.2 g on average) and shell breaking strength (by 2.58 N on average). Shell thickness, shell colour and shell density values were dependent mainly on hen genotype.

Discussion

Linseed contains substantial amounts of phytoestrogens, which may affect hatchability results, fatty acid profile and egg quality (Souza et al., 2008). The present study with heritage breed hens also found a positive effect of linseed on productivity. Because of low egg production performance in heritage breeds, feed intake per egg is much higher compared to highly productive commercial hybrids. However, the improvement of this parameter in response to the diet was much higher than in similar studies by Caston et al. (1994) and Augustyn et al. (2006). This value of feed conversion efficiency was also affected by a significant increase in percent egg production in the experimental groups.

The supplementation of hen diets with linseed significantly increased egg weight. However, there are no conclusive results concerning this in the literature. Increases in egg weight in response to linseed supplementation were reported by Novak and Scheideler (2001) and Połtowicz and Wężyk (2005), and by Hazim et al. (2010) for quail. Meanwhile, Bean and Leeson (2003) reported a downward trend for both egg weight and yolk weight, while Basmacoglu et al. (2003) found that the dietary addition of linseed and fish oil had no negative effect on egg weight and shell thickness. Research results confirm a relationship demonstrated by Keshavarz and Nakjima (1995) that in addition to hen genotype, egg weight depends strongly on energy and nutritive value of the feed. In commercial flocks, egg weight determines the majority of other egg and shell quality traits. According to Zhang et al. (2005), egg weight shows high genetic correlations with albumen height, yolk weight and shell weight. Our study shows that a similar relationship but between egg weight and shell weight may occur in conservation populations not selected for production traits. Heritage breeds/lines are characterized by a much higher yolk percentage in egg weight compared to highly productive commercial hybrids (Krawczyk, 2009), and this relationship was not changed by the treatment factor. Neither did feeding hens a linseed diet influence albumen height and Haugh units (an indicator of egg freshness), because this parameter depends mainly on the length and conditions of egg storage (Bell et al., 2001).

Yolk colour intensity is a significant parameter from the consumer's point of view that determines the demand. Yolk colour and yolk colour intensity depend mainly on the hen's diet. Our study showed that the eggs of hens from the experimental groups were characterized by better (more intense) yolk colour ($P<0.001$). A similar relationship was found by Grobas et al. (2001), Połtowicz and Wężyk (2005) and Augustyn et al. (2006) who supplemented highly productive hens with both linseed and other plant fats. The higher fat content of the linseed diets could increase the intestinal absorption of fat-soluble xanthophylls, which have a positive effect on yolk colour intensity (Grobas et al., 2001). A higher number of blood spots in the yolks of eggs from brown-feathered (brown genotype) hens was also observed elsewhere (Abrahammson et al., 1996; Wall et al., 2010). However, Wall et al. (2010) observed no effect of a mussel meal diet fed to laying hens on the number of blood spots. In our study, the number of blood spots was slightly lower in the linseed-supplemented groups.

The treatment factor had no effect on egg shell colour, because this parameter correlates strongly with hen genotype (Scholtyssek, 1988). On the other hand, the addition of linseed to hen diets positively affected shell breaking strength, which is important from the consumer and marketing perspective. Similar findings were reported by Caston et al. (1994). Grobas et al. (2001), who supplemented high-producing laying hens with different fats, found shell quality to be improved by animal fat rich in fatty acids (lard), whereas plant fats (including linseed oil) containing high amounts of unsaturated fatty acids caused no change. Likewise, Bean and Leeson (2003) reported that adding 10% linseed to hen diets caused no changes in egg shell traits.

It was found from this study that the 10% linseed diet used in the feeding of heritage breed hens had a positive effect on production results and most physical characteristics of eggs important for the consumer such as egg weight, yolk weight, yolk colour, and shell breaking strength. The highly significant differences between the breeds/lines of hens for most physical characteristics of eggs show that the analysed hens are characterized by biodiversity.

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Efektywność stosowania nasion lnu w żywieniu kur ras zachowawczych

STRESZCZENIE

Celem badań było określenie wpływu żywienia mieszankami z udziałem lnu kur sześciu ras/rodów zachowawczych na produkcyjność i jakość jaj. Materiał doświadczalny stanowiły kury ras/rodów objętych programem ochrony zasobów genetycznych tj.: Zielononóżka kuropatwiana (Z-11), Żółtonóżka kuropawiana (Ż-33), Rhode Island Red (R-11), Sussex (S-66), Leghorn (rody: H-22 i G-99). Nioski każdej rasy/rodu (po 180 sztuk) przydzielono do 2 grup żywieniowych: kontrolnej (K) żywionej standardową mieszanką pełnoporcjową oraz doświadczalnej (L) z 10% udziałem dodatku nasion lnu (odmiana Opal). Każda grupa składała się z 4 powtórzeń. Stwierdzono korzystny wpływ stosowania mieszanek z 10% udziałem nasion lnu w żywieniu kur ras zachowawczych na wyniki produkcyjne i większość, ważnych dla konsumentów cech fizycznych jaj tj.: masę jaja, barwę żółtka oraz wytrzymałość jaj na zgniecenie. Zanotowano statystycznie istotny wpływ rasy/rodu na wszystkie omawiane cechy jakości jaj z wyjątkiem wytrzymałości skorup na zgniecenie, co potwierdza bioróżnorodność omawianych kur.