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The effect of differentiated dietary protein level on the performance of breeder quails

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Modern quail breeds and varieties show differentiated nutritional requirements. Particularly the amount of protein consumed, as well as dietary energy to protein ratio determine the production results. The present study was aimed at determining the effect of isoenergetic diets differing in crude protein (CP) content, on the performance of Pharaoh quails. Three groups of birds (I, II and III) were fed with feed mixes containing 21, 19 and 17% CP, respectively. During 23 weeks their laying performance, egg weight, mortality rate, feed consumption and body weight were recorded and egg quality assessed.

The dietary CP level did not affect the final body weight of birds significantly, and mortality was similar in all groups. In group III (17% CP of the diet) laying performance was significantly lower than in group I and II, while no differences were found in egg weight and quality. Feed conversion ratio (kg feed per kg eggs laid) was lowest in group III.

KEY WORDS: egg quality / egg production / feed conversion / low-protein diet / quail / mortality

In some cases the progress achieved in genetic improvement of poultry prompts for updating of feeding standards. At present, poultry producers are offered feed mixes with protein and energy contents lower than those stipulated by NRC (National Research Council). Research related to modification of feeding was carried out mostly on chickens [Pinchasov and Jensen 1989, Koreleski and Świątkiewicz 1999, Świerczewska *et al*. 2000], but also on turkeys [Hester and Stevens 1990] and ducks [Hocking 1990], whereas only occasionally on quails [Zelenka *et al*. 1984, Gebhart-Heinrich and Marks 1995, Ocak and Erener 2005]. A number of experiments performed

on quails refer mainly to the influence of restricted feeding on quail growth and reproductive indicators, but the results are frequently inconsistent due to, among others, different methods of limited feeding applied [Zelenka *et al*. 1984, Gebhart-Heinrich and Marks 1995, Ocak and Erener 2005]. In Poland, popularity of quail increases, but currently the research on its feeding requirements is not carried out. There are some differences within the nutritional requirements of quails as determined by various authors. According to Larbier and Leclercq [1995] the protein level of a quail feed should vary from 18 to 20% during the laying period, while Rutkowski [2000] recommends the constant level of 21%. It seems that production results are determined not by protein amount, but first of all by energy to protein ratio.

In the light of the above, a study was undertaken with the aim to assess possibility of applying low-protein feed mixes in quail feeding and to examine their effect on selected production parametres and egg quality.

Material and methods

From the Faraoh quail flock kept at the Department of Poultry and Ornamental Birds Breeding, Agricultural University of Szczecin, three groups of birds of similar body weight were formed in four repetitions (24 females and 8 males in each). Used were feed mixes designed for adult quails (Tab. 1), with a crude protein (CP) level equal to, or lowered in relation to that recommended by the Institute of Animal Physiology and Nutrition [1996], and fed *ad libitum*. According to that, birds of group I (control) were fed a mix containing 21.0% CP and 11.71 MJ ME, whereas those of group II and III – 19.0% CP and 11.66 MJ ME and 17.0% CP and 11.68 MJ ME, respectively. Energy to protein ratio amounted to 0.56, 0,61 and 0.67 in mix for group I, II and III, respectively. The quails were kept in group cages in a room with the air temperature of 19-20°C and light undergoing natural changes, not shorter, however, than 17 hours per day. The birds had free access to feed and water, residuals being weighed twice a week. Observation period lasted 23 weeks.

Laying performance, egg weight as well as mortality and cullings for health reasons were recorded. On week 23 the final body weight, daily feed intake per bird, feed consumed per one egg and per 1 kg eggs laid were determined.

Egg quality was assessed of 30 eggs from each group. The egg specific gravity was determined in sodium chloride solutions with density from 1.058 g/cm^3 to 1.082 g/cm^3 increasing successively by 0.004 unit, as well as the egg shape index and egg morphological composition with the use of standard equipment. Also egg white and yolk indices and pH were determined, the latter with Sentron 3001 pH-meter.

The collected numerical data were evaluated statistically with one-factor analysis of variance and the Duncan's test using STATISTICA 6.0 software package.

Results and discussion

Both experimental diets (group II and III) contained slightly less crude fibre and lysine compared to control diet (group I). The remaining nutrients were at similar levels (Tab. 1).

Table 1. Ingredients and chemical composition of feed mixes for quails (%)

Item	Group I	Group II	Group III
Barley meal	15.00	16.00	16.20
Corn meal	25.00	15.00	15.00
Wheat meal	17.75	36.42	40.99
Extracted soybean meal (46% CP)	24.30	21.00	17.00
Daka meal (55% CP)	4.70	3.50	2.50
Dried grass (14-16% CP)	3.00	-	-
Soybean oil	1.50	0.50	0.20
NaCl	0.19	0.25	0.28
VIT-TRA-LAC	2.00	-	-
Toyocerin	0.04	0.02	0.02
L-lysine hydrochloride	0.12	0.20	0.25
DL-methionine	0.12	0.11	0.11
Kemzyme dry	0.10	0.10	0.10
Myco carb	0.10	0.10	0.10
Polfasol E	0.01	0.01	0.01
Polfasol AD_3	0.01	0.01	0.01
Lutamix EDKA-F	0.50	0.50	0.50
Limestone	4.75	4.60	4.70
1-Ca Phosphate	0.85	-	-
2-Ca Phosphate	-	1.70	2.05
Metabolic energy (MJ)	11.71	11.66	11.68
Crude protein (%)	20.93	19.09	17.20
Fibre (%)	4.4	3.6	3.5
Calcium (%)	2.5	2.5	2.5
Available phosphorus (%)	0.5	0.5	0.5
Lysine (g)	11.61	10.80	9.90
Methionine (g)	7.57	7.50	6.8
Vitamin A (i.u.)	15717	15691	15327
Vitamin D_3 (i.u.)	4500	4483	4289
Lysine content of crude protein (%)	5.55	5.64	5.74
Lysine + methionine to cystine/threonine/tryptophan ratio	100:65: 65:20	100:67: 63:20	100:69: 61:20

On week 6 of life, the mean body weight of both males and females was similar in all groups – 172.5g and 182.6g, respectively. In the final stage of experiment, *i.e*. in week 29 of life, the body weight of birds was not found to be changed markedly (Tab. 2). The body weight of females ranged from 182.0 g (group II) to 185.0 g (group I and III), whereas that of males from 173.0 g (group I) to 180.0 g (group II). The males of group II (19% CP) were the heaviest, but the inter-group differences were not confirmed statistically.

Table 2. Body weight and mortality in quails

Item	Group I	Group II	Group III
Body weight (g)			
week 6 of life			
males	183.0±21.98	183,0±20.41	182.0±21.31
females	172.0±2.88	172.5±2,99	172.5±2.68
week 29 of life			
males	185.0±17.21	182.0 ± 12.92	185.0±15.35
females	173.0±3.25	180.0 ± 5.78	176.0±2.97
Mortality	4	3	4

In quails and broiler chickens, protein content of feed affects the birds'growth, mostly in the first stage of life. The higher is its content, the higher is their body weight [Hocking 1990, Yaisle and Lilburn 1998, Zeweil and Zeid 1999, Świerczewska *et al*. 2000, Ocak and Erener 2005].

In adult birds, after the completion of ossification period and somatic growth, the effect of dietary CP level on body weight was not remarkable. According to Ocak and Erener [2005], the method of quail feeding during the rearing period influenced their body weight. When reducing the protein supply by 30% in relation to the full recommended demand between day 15 and 28 of life, they found a lower body weight in quails on day 42 of life, whereas the dressing percentage and breast muscle percent of carcass were similar in both groups of birds, *i.e.* fed *ad libitum* (full demand) *vs*. the restricted feeding. According to Zelenka *et al*. [1984], the restrictive method of feeding did not influence the body weight of quails commencing the egg laying stage. Hassan *et al*. [2003] demonstrated that the restricted feeding system of rearing quail females affects mainly their body weight, with no, however, negative influence on reproductive performance.

Mortality during laying period was at similar level in all groups (Tab. 2). The main reason of bird deaths proved to be traumatic injuries. Gebhart-Henrich and Marks [1995] when applying the restrictive method in quail feeding, found mortality rate twice as high in experimental than in control groups.

The lowest daily feed intake (Tab. 3) was stated in group III – 26.3 g – while 30.7 in controls and 31.7g/bird in group II (inter-group differences not significant). On the other hand, Ocak i Erener [2005] claim that lower feed consumption can be achieved when the restricted feeding method is applied.

Table 3. Laying performance and feed consumption of quails (up to week 29 of life)

Item	Group I	Group II	Group III
No. of eggs laid	88.4^{a}±11.01 (100%)	81.6^{a}±10.13 (92.3%)	66.1^{b}±13.25 (74.8%)
No. of eggs/layer	144^{a}±10.12	135^{a}±7.81	109^{b}±11.82
No. of eggs/layer/week	6.1^{a}±1.03	5.6^{a}±0.92	4.8^{b}±1.23
Feed (g) consumed/bird/day	30.7±4.38	31.7±5.96	26.3±6.12
Feed (g) consumed/egg laid	35.0±5.17	35.0±6.21	30.8±5.93
Feed (kg) consumed/kg eggs laid	3.2±0.47	3.2±0.39	3.0±0.53

Within rows means bearing different superscripts differ significantly at $P \leq 0.05$.

Lower daily feed consumption per bird was shown by Richtrova [1999] in a group of Japanese quails kept without males and fed with standard mixed diet, as well as by Kosieradzka *et al*. [2000], the latter results, however, referring to lighter birds.

Feed consumption per one egg laid was the lowest in group III (30.8 g), in group I and II amounting to 35 g (Tab. 3). Lowering the protein level to 17% (group III) caused a decrease in feed consumption. Therefore, the feed intake per one egg laid in this group appeared lowest despite the lower laying performance. The obtained values of these indices in group I and II did not differ from the data presented in literature [Shanawany 1994, Tarasewicz 1998].

Most eggs/layer was laid by females from group I (144), by 9 eggs more than from group II (135). Lowering of dietary protein level to 17% caused a dramatic ($P \leq 0.05$) decrease in laying performance. In the observed period of time, 109 eggs/layer were obtained in group III. The index of laying performance in experimental groups amounted to 66.1% (group III) and 81.6% (group II) with 88.3% in control group (Tab. 3). In the earlier studies on Pharaoh quails the authors reported laying indices at the level of 78-87%. Thus, the parametre found in quails of group I and II in the current experiment remains within that range. On the other hand, the value of laying index stated in group III approximated that characteristic of Golden variety quails [Tarasewicz 1998, Tarasewicz *et al* 2004]. Similar value of the index, though calculated for a shorter laying period, was given by Kosieradzka *et al*. [2000]. The highest weekly egg production per layer was reached in control group – 6 eggs – with the mean of 4.8 eggs in group III. The lowest egg weight was observed in group III (10.32 g), differing significantly from that in control group (10.85 g) and group II

(10.99 g). According to Hassan *et al*. [2003], restricted feeding used during the rearing period does not affect the laying volume or the egg weight.

The weight of albumen in the eggs examined ranged from 6.06 g (group III) to 6.51g (group I). Significantly least egg white was stated in quails fed with feed mix containing 17% protein, whereas the white content (%) of egg did not differ significantly between groups (Tab. 4). The yolk weight in eggs was similar in all groups and amounted from 3.13 (group III) to 3.41g (group II). The yolk content of egg was most favourable in group II (30.97%), being significantly higher than in remaining two groups.

Table 4. Morphological composition of quail eggs

Item	Group I	Group II	Group III
Egg weight (g)	10.85^{a}±0.52	10.99^{a}±0.53	10.32^{b}±0.74
Albumen weight			
g	$6.5l^{a}$±0.24	6.41^{a}±0.32	6.06^{b}±0.44
%	60.04±2.34	58.29±1.28	58.77±2.42
Yolk weight			
g	3.17±0.31	3.41±0.25	3.13±0.36
%	29.17^{a}±l.77	30.97^{b}±l.34	30.22^{a}±2.30
Egg shell weight			
g	1.17±0.20	1.17±0.21	1.13±0.18
%	10.79±1.67	10.74±2.04	11.01±1.63
Albumen-yolk ratio	2.05 : 1	1.88 : 1	1.94 : 1

Within rows means bearing different superscripts differ significantly at P≤0.05.

The egg shell weight did not show any differences between group I and II and amounted to 1.17 g, constituting 10.79 and 10.74% of egg weight, respectively. In group III, the egg shell weight was similar, constituting, however, a higher per cent of egg weight (11.01%), non-significantly different from those of other groups. The most favourable white to yolk ratio was found in group II (1.88:1) – Table 4. Similar data were presented by Singh and Panda [1987] who claimed that relations between the two egg components are similar to those existing in chicken.

The eggs coming from the layers fed with diets differing in CP content did not differ significantly in most morphological traits considered in this study. However, the egg yolk index (Tab. 5) in control group (0.51) was significantly higher than indexes found in two remaining groups. In control group greater (not, however, significantly) was also the egg white height. No effect of low-protein diet was demonstrated on egg shape index which is of importance in commercial trade.

Table 5. Morphological traits in quail eggs

Item	Group I	Group II	Group III
Egg shape index	79.61^{a}±2.89	76.77^{a}±5.21	81.24^{b}±2.72
Albumen height (mm)	6.06±0.60	5.63±0.80	5.64±0.76
Albumen index	0.15±0.02	0.14 ±0.02	0.15±0.03
Albumen pH	8.90±0.012	9.05±0.011	9.06±0.010
Yolk index	0.51^{a}±0.17	0.40^{b}±0.05	0.43^{b}±0.09
Yolk pH	6.22^{a}±0.023	6.24^{a}±0.017	6.37^{b}±0.012
Specific gravity (egg density)	1.0658±0.0006	1.0627±0.0010	1.0652±0.0009

Within rows means bearing different superscripts differ significantly at P≤0.05.

Higher egg white and yolk pH values were found in both experimental groups, with significantly highest yolk pH in group III (6.37) – Table 5. Unfavourable changes in pH value of main egg components contribute to acceleration of egg ageing, and thus lower its processing value as well as consumption quality [Trziszka 1994].

The results presented here can be summarized as follows. The crude protein level of mixed diet (21, 19 and 17%) fed *ad libitum* did not affect the body weight of adult quails of both sexes. Feeding quails with the mixed feed of the lowest crude protein content (17%) resulted in significant fall in laying performance traits, with the highest yolk content (%) of egg. Experimental feed mixes had no significant effect on the majority of evaluated egg qualitative traits, but they significantly reduced the value of yolk index. No significant effect of low-protein diet was found on feed consumption per one egg and per 1 kg eggs laid.

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Wpływ zróżnicowanego poziomu białka w paszy na użytkowość przepiórek reprodukcyjnych

S t e s z c z e n i e

Współcześnie utrzymywane rasy i odmiany przepiórek charakteryzują się zróżnicowanymi wymaganiami pokarmowymi. Z wielu prac wynika, że ilość białka, a przede wszystkim stosunek energii do białka decyduje o wynikach produkcyjnych. Celem podjętych badań było określenie wpływu żywienia dietami o zróżnicowanej zawartości białka ogólnego, przy zachowaniu ich energetyczności na podobnym poziomie, na użytkowość przepiórek rasy faraon.

W doświadczeniu utworzono trzy grupy ptaków – I, II i III – otrzymujące mieszanki paszowe o zawartości odpowiednio 21, 19 i 17% białka ogólnego. W trakcie 23-tygodniowego użytkowania ewidencjonowano nieśność, masę jaj, śmiertelność, spożycie paszy, masę ciała oraz przeprowadzono ocenę jakości jaj. Poziom białka w mieszance nie miał wpływu na końcową masę ciała ptaków. Śmiertelność we wszystkich grupach była na zbliżonym poziomie. Obniżenie poziomu białka w diecie do 17% spowodowało istotne obniżenie nieśności, nie stwierdzono natomiast różnic w masie i jakości jaj. Zużycie paszy na kg jaj było najmniejsze przy skarmianiu mieszanki zawierającej 17% białka ogólnego.