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The use of Avoparcin (Avotan) in laying hens feeding

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ABSTRACT

Two experiments were carried out with 192 hybrid Tetra SL hens kept in cages (A) and 5340 medium-weight Hisex Brown layers kept on litter (B). Experimental diets contained 16 (A) or 18% (B) crude protein and about 11.2 MJ ME/kg. Five or 10 (A) and 10 or 20 (B) ppm of Avoparcin (Avotan) were added to the experimental diets. The laying rate, egg mass, feed intake, mortality, egg quality and Ca, inorganic-P and Mg levels in blood serum were investigated.

In experiment A Avoparcin in both 5 and 10 ppm concentration did not affect the laying rate which averaged 85.7%. In experiment B the dose of 10 ppm Avoparcin increased the laying rate by 18%, 20 ppm by 6%.

The improvement of feed utilization per egg by 6% and the strength of the shell by about 10% after Avoparcin addition were observed in Experiment B only.

The influence of antibiotic on the mineral components of the blood was negligible and only the level of inorganic P varied.

KEY WORDS: laying hens, Avoparcin, performance

INTRODUCTION

Supplementation of feed mixtures with biologically active substances – feed antibiotics – improves performance and has a beneficial effect on the health of broiler chickens (Dutta and De Vriese, 1980; Hofshagen and Kaldhushal, 1992; Holmberg et al., 1984; Meixner, 1991; Richter and Ranft, 1991).

The number of comprehensive studies on the effect of feed antibiotics on the performance of laying hens is lower, although a few studies have already been conducted (Branion et al., 1957; Tüller, 1969, 1973). There is a concern that with long-term prophylactic utilization trace amounts of feed antibiotics or their metabolites may be transfered into the egg (Tropiło and Stępień, 1989). Currently used feed antibiotics were registered as feed additives after passing tests confirming that these substances or their metabolites do not pass into such animal products as meat, milk or eggs.

Some authors stress that supplementation of laying hen diets with feed antibiotics may have a beneficial effect on the quality of egg shells (Jamroz et al., 1984; Latała et al., 1983; Rosen, 1986; Solomon, 1990; Fioretti et al., 1991).

Avoparcin (Avotan) has not been registered as a feed antibiotic for laying hens in Poland to date, hence this study on its influence on laying indices, feed utilization, quality of eggs, as well as egg shell strength was undertaken. Blood plasma was also tested for Ca^{+2}, P, and Mg^{+2} levels. Changes in these parameters were previously found in the blood plasma of chicks (Jamroz et al., 1992).

Eggs obtained from the experimental hens were tested for the presence of Avoparcin or its metabolites, what is a subject of a separate paper (Report, 1993).

MATERIAL AND METHODS

Experiment A

Experiment A was conducted under controlled environmental conditions on 192 medium-weight hens – Tetra SL hybrids, aged 19 weeks. The hens were weighed and randomly allocated into three feeding groups, each containing 16 cages with 4 hens in each one. All birds were uniformly fed, with standard DKM-2, then DJ mixtures until the beginning of egg production. After reaching the 40% laying rate the birds were kept further on standard DJ mixture:
group I – without the antibiotic,
group II – the same with 5 ppm of Avoparcin added,
group III – the same with 10 ppm of Avoparcin included.

The antibiotic was given in the form of a 10% premix, Avotan (Cyanamid).

Blood samples were taken from the wing vein of 12 randomly chosen birds thrice, beginning at the peak of laying (in the 32nd week of the hen's life) and after each 6 consecutive weeks in order to determine the level of minerals in the blood plasma. Inorganic phosphorus, calcium, and magnesium contents were determined using the Biochemotest, POCh, Gliwice (Poland) and Merck Test 3388.

At the same time the basic parameters of egg quality were determined using the methods of Scholtyssek (1975) and Scholtyssek and Trziszka (1985). The strength of the shell was expressed as the percent of eggs whose shells did not crack under pressure of 3.5 kg.

The chemical composition of the feed components was determined by standard methods and the metabolizable energy value of the diet was calculated.

Statistical analysis of all experimental data using variance and covariance analysis was performed.

Experiment B

A field test (B) was performed in a standard building on a litter between May and October of 1992, on 5340 middle-weight Hisex Brown hens. The birds were randomly assigned into three feeding groups (in two trials), each containing about 1780 animals. At the beginning of the experiment, 30 randomly chosen hens out of each group were weighed. The test was begun in the seventh month of the laying period when average egg production was 69% and average body mass of the hens was about 1.8 kg. The flock of hens chosen for the experiment did not reach a high level of production but it was assumed that under less favourable conditions antibiotic effectiveness should be more visible. The average feed intake in this flock was below only 90g/day so the protein content in the feed was increased to 18.2% hoping for stimulation of the laying process. As in experiment A the control group received the unsupplemented diet, group II the diet with 10 and group III with 20 ppm of Avoparcin added. During the experiment eggs were collected every day, and weighed once a week. Feed utilization and hen mortality were noted.

As like in experiment A, blood was sampled twice after 16 and 22 weeks of the test and levels of inorganic P, Ca^{+2} and Mg^{+2} determined. During the same periods eggs were tested for quality and shell strength as in experiment A. Shell strength was expressed in Newtons (1N = a pressure of 100g).

Microbiological determination of the presence of Avoparcin residues was done at the Institute of Veterinary Hygiene and Food Control in Budapest on 20 randomly chosen eggs from each group. The test was made using the method recommended by ISO/WHO with *Bacillus subtilis* BGA and is described in a separate paper (Report, 1993).

RESULTS

Experiment A

Although hens were assigned to their experimental groups randomly, it happened that hens in groups II and III were lighter by 40-70 g on average and

TABLE 1

Composition of concentrates (Experiments A and B), %

Compounds	Experiment A	Experiment B
Ground wheat	30	48
Ground maize	38	20
Soya bean meal	15	18
Fish meal	2	–
Meat-and-bone meal	3	2
Livex	–	2
Fodder yeast	–	2
Grass meal	4	–
Limestone	6.5	6.5
Dicalcium phosphate	0.7	1.0
Premix DJ[1] (without antibiotic)	0.5	0.5
NaCl	0.3	–
Metabolizable energy, MJ/kg	11.1	11.3
Crude protein, %	16.6	18.2
Crude fibre, %	3.7	3.1
Ca, %	3.20	3.17
P-total, %	0.57	0.46
Amino acids, %		
Lys	0.74	0.84
Met	0.31	0.30
Met + Cys	0.53	0.52

[1]Containing: 2000 000 i.u./kg vit. A, 400 000 i.u./kg vit. D_3, (g/kg) – vit. E 3.0; vit. K_3 0.6; vit. B_1 0.4; vit. B_6 0.12; vit. B_{12} 0.0032; nicotinic acid 6.0; pantothenic acid 2.8; Mn 8.0; Fe 4.0; Zn 3.0; Cu 0.4; Co 0.2

their laying rate during the first 10 days lower by 9 and 21%, respectively, in relation to the control group. Because of the already established hierarchy in the cages, it was decided that exchange of the birds in order to even out the average was not indicated since it could lead to cannibalism. At the termination of the laying period the hens obtaining Avoparcin gained 18 and 28% more than the controls (Table 2).

The average weekly laying rate of hens, over the 319 days of the experiment, totaled 86 (I), 86 (II) and 85% (III). Hens receiving Avoparcin quickly compensated for the poor start in egg production and reached almost the same laying rate and a similar number of eggs per hen, averaging 261, 262 and 258, respectively.

No significant difference was noted in the weight of the eggs, which in all groups amounted to 61 g, on average. By the end of the experiment hens receiving Avoparcin were heavier and as a result, consumed slightly higher amounts of feed per day, 127 vs. 124 g. They also used more feed per egg, 156 vs. 151 g, and for 1 kg egg mass by 2.5 and 3.6% (Table 2).

TABLE 2

Results of Experiment A (means ± SD)

Indices	Control	+ 5 ppm Avoparcin	+ 10 ppm Avoparcin
Body weight of hens, kg			
– initial	1.42 ± 0.05	1.38 ± 0.06	1.35 ± 0.07
– final	2.03 ± 0.17	2.10 ± 0.10	2.13 ± 0.11
Weight gain, kg	$610^{A} \pm 110$	$720^{Ba} \pm 90$	$780^{Bb} \pm 103$
Average laying rate,%			
– initial	$44.1^{Aa} \pm 4.3$	$40.2^{a} \pm 2.4$	$35.0^{Bb} \pm 3.7$
– average for 319 days	$85.8^{a} \pm 0.97$	$85.7^{a} \pm 1.03$	$85.6^{a} \pm 1.33$
Egg weight, g	61.2 ± 0.63	61.3 ± 0.78	61.4 ± 0.98
Total egg weight per layer, kg	16.00^{a}	16.06^{a}	15.86^{a}
Total egg number per layer, kg	261.5^{a}	261.8^{a}	258.3^{a}
Feed intake			
– per head/day, g	123.6 ± 21	126.8 ± 19	126.8 ± 23
– per one egg, g	150.7 ± 23	154.7 ± 17	156.5 ± 21
– per 1 kg of egg mass, kg	2.46	2.52	2.55
Crude protein intake			
– per head/day, g	20.5 ± 3.0	21.0 ± 4.1	21.0 ± 4.1
– per one egg, g	25.5 ± 2.9	25.7 ± 4.3	25.9 ± 4.4
– per 1 kg of egg mass, kg	409.2	417.9	423.3
Mortality and losses, head	4	4	3

Differences between groups were statisticall significant a,b – $P \leqslant 0.05$; A,B – $P \leqslant 0.01$; average laying rate was calculated proportionally to week-mean number of hens

TABLE 3

Concentration of minerals in blood serum (means ± SD)

Experiment A			
Indices	Control	+ 5 ppm Avoparcin	+ 10 ppm Avoparcin
Ca^{+2}, mmol/l	$4.01^{a} \pm 0.23$	$4.03^{a} \pm 0.23$	$4.02^{a} \pm 0.29$
P-inorganic, mmol/l	$1.98^{A} \pm 0.34$	$1.79^{Bb} \pm 0.21$	$1.88^{b} \pm 0.29$
Mg^{+2}, mmol/l	$1.52^{a} \pm 0.13$	$1.52^{a} \pm 0.14$	$1.55^{a} \pm 0.12$
Experiment B			
Indices	Control	+ 10 ppm Avoparcin	+ 20 ppm Avoparcin
Ca^{+2}, mmol/l	2.96 ± 0.60	2.94 ± 0.44	2.92 ± 0.38
P-inorganic, mmol/l	1.73 ± 0.25	1.85 ± 0.28	1.84 ± 0.29
Mg^{+2}, mmol/l	1.30 ± 0.27	1.30 ± 0.38	1.45 ± 0.22

Experiment A – differences between groups statistically significant a,b – $P \leqslant 0.05$; A,B – $P \leqslant 0.01$; Experiment B – all differences between groups were statistically insignificant

In consequence, they utilized 2% more protein per hen per day, and also used a larger amount of protein for the production of 1 egg (by 2 and 3% for 1 kg of egg).

The health of the hens did not raise any questions, although due to eversion of the oviduct, especially by the end of the laying period, some hens had to be eliminated from the experiment.

The level of Ca^{+2} in blood serum totaled 4.02 mmol/l on average and was similar in all groups (Table 3). A relatively lower level of inorganic P was noted in the serum of hens in groups II and III. The difference in relation to the control group was 9.6 (II) and 5.1% (III), with individual variations exceeding 10%.

The Mg^{+2} content was found to be similar in all hens (1.52 mmol/l). The concentration of the tested minerals in the plasma fell within accepted physiological norms.The antibiotic had no significant effect on egg quality (Table 4). All measured parameters fell within the accepted standards for edible eggs (Scholtyssek, 1975).

Experiment B

In comparison with the control group , hens receiving feed containing 10 ppm of Avoparcin had an 18% higher laying rate, those receiving 20 ppm, a 6% higher rate (Table 5). It should be stressed that for 3 months (between June and August) the weather was hot and the temperature inside the building reached +30°C.

The average weight of eggs did not differ significantly among the groups and amounted to: 61.2 (I), 61.4 (II) and 62.7g (III). It was slightly (2.4%) higher in group III, in relation to the control.

The mortality rate in group III was about the same as in group I, and higher than in group II. The relatively high mortality was to a large extent due to the hot weather, which could also have negatively affected egg production.

The consumption of feed (Table 5) per day per hen was low in all groups (88-98g). However, the increased concentration of protein in the feed protected the hens from a laying depression which was observed at the same time on other poultry farms due to the heat wave.

Feed consumption per egg amounted to 155g in the control group, 145g in group II, and 156g in group III. For 1 kg of egg mass the hens used 2.53 (I), 2.37 (II) and 2.50 kg (III) of feed, which is 6.4 and 1.2 % less in relation to the control. Protein consumption was 16-17 g per day/per bird and fell within the normal range but per egg was slightly elevated (26-28 g, with the norm at about 25 g).

The concentration of minerals in the blood serum varied, so the differences in the amount of inorganic P, magnesium and calcium were shown to be statistically insignificant, although in the hens receiving the antibiotic the level of inorganic P was 6% higher (Table 3). The Avoparcin added to the feed did not affect the

TABLE 4

Egg characteristics (Experiment A, means ± SD)

Indices	Control	+ 5 ppm Avoparcin	+ 10 ppm Avoparcin
Egg albumen			
– Hough units	62.1 ± 5.3	62.7 ± 5.0	61.9 ± 4.8
– pH	8.81 ± 0.15	8.76 ± 0.18	8.86 ± 0.17
Egg yolk			
– index	40.5 ± 3.0	41.9 ± 3.4	42.4 ± 3.1
– pH	6.77 ± 0.12	6.70 ± 0.17	6.68 ± 0.14
Share in egg, %			
– shell	9.9 ± 1.1	9.7 ± 0.8	9.9 ± 1.0
– albumen	61.3 ± 3.8	62.2 ± 4.1	61.4 ± 4.0
– yolk	28.8 ± 1.7	28.1 ± 2.0	28.7 ± 1.9
Strength of egg shell, %	80.0	81.0	80.0

All differences between groups were statistically insignificant. Strength of shell was estimated as a percent of egg strengthed against the pressure of 3.5 kg

TABLE 5

Results of Experiment B (means ± SD)

Indices	Control	+ 5 ppm Avoparcin	+ 10 ppm Avoparcin
Initial number of hens	1776	1878	1680
Body weight of hens			
– initial, kg	1.78	1.83	1.81
Average laying rate, %			
– initial	66.4	69.7	70.1
– average for 184 days	56.9	67.0	60.3
Egg weight, g	61.2 ± 0.61	61.4 ± 0.70	62.7 ± 0.68
Feed intake			
– per head/day	88.6	97.6	94.7
– per one egg	155.1	145.3	156.8
– per 1 kg of egg mass	2.53	2.37	2.50
Crude protein intake			
– per head/day, g	16.2	17.8	17.3
– per one egg, g	28.3	26.5	28.6
– per 1 kg of egg mass, kg	462.3	431.8	456.1
Mortality, %	7.32	6.60	7.25

Average laying rate was calculated proportionally to week – mean number of hens

TABLE 6

Egg characteristics (Experiment B, means ± SD)

Indices	Control	+ 5 ppm Avoparcin	+ 10 ppm Avoparcin
Egg albumen			
– Hough units	$72.8^{a} \pm 5.3$	$72.4^{a} \pm 6.1$	$69.5^{a} \pm 4.2$
– pH	$8.40^{a} \pm 0.14$	$8.35^{a} \pm 0.10$	$8.42^{a} \pm 0.20$
Egg yolk			
– index	$43.4^{a} \pm 3.7$	$43.1^{a} \pm 2.9$	$44.5^{a} \pm 4.1$
– pH	$6.70^{a} \pm 0.14$	$6.69^{a} \pm 0.17$	$6.71^{a} \pm 0.15$
Share in egg, %			
– shell	$9.3^{a} \pm 0.9$	$9.3^{a} \pm 1.0$	$9.4^{a} \pm 1.0$
– albumen	$61.6^{a} \pm 4.1$	$61.0^{a} \pm 4.0$	$60.6^{a} \pm 3.7$
– yolk	$29.1^{a} \pm 1.9$	$29.7^{a} \pm 2.0$	$30.0^{a} \pm 2.1$
Egg shell			
– thickness, mm	$0.35^{a} \pm 0.01$	$0.37^{b} \pm 0.02$	$0.36^{ab} \pm 0.01$
– strenght, N	$28.5^{A} \pm 2.0$	$31.5^{B} \pm 1.6$	$31.0^{B} \pm 1.9$

Differences between groups statistically significant a, b – $P \leq 0.05$; A, B – $P \leq 0.01$

proportion of shell, white or yolk in the egg or the quality parameters or pH of the egg white and yolk (Table 6). Statistically significant changes were found only in the quality parameters of the shell. They did not change in experiment A, but in experiment B the strength of the shell increased by 10 (II) and 9% (III) and the thickness of the shell by about 3%. This positive aspect of the effect of the antibiotic could have a technological significance since experiment B was conducted during a long-lasting heat wave (June – August 1992).

DISCUSSION

Due to the small amount of information in the literature about the recommended concentrations of Avoparcin, doses of 5 and 10 ppm were applied in experiment A, and 10 and 20 ppm in experiment B, which is close to those recommended for other feed antobiotics (Jamroz et al., 1984; Keppens and De Groote, 1980; Rosen, 1986; Ruff and Jensen, 1977; Solomon, 1990; Zgłobica et al., 1985). The results obtained in both experiments differed, due to the different levels of antibiotic used and different management practice. In experiment A, in spite of the addition of 5 and 10 ppm of Avoparcin to the feed of hens held in cages, average egg production was similar for all the groups – 85.7%.

In cages contact with excreta is limited, the amount of microorganisms in the environment is smaller, so the action of the antibiotic might be less visible. More pronounced differences between groups were observed in experiment B, however, in which the animals were kept on litter. An addition of 10 ppm of the antibiotic raised the laying rate by 18%, addition of 20 ppm by 6.0%. Such favourable effects of the antibiotic in laying hens were not reported by other authors (Jamroz et al., 1984; Rosen, 1986; Ruff and Jensen, 1977, Solomon, 1990). It seems that in this case Avoparcin diminished the negative effect of the thermal stress during the 3 month heat wave, which allowed for improvement in egg production. Addition of the antibiotic to the feed did not affect the weight of the eggs, which averaged about 61 g in both experiments, and only with 20 ppm of Avoparcin did this average slightly increase.

No effect of the antibiotic on feed intake was found in birds kept in cages, but in birds kept on litter feed intake was higher. Recalculated to 1 kg of egg, the savings of feed amounted to 6.4%, with the addition of 10 ppm, and 1.2%, with the addition of 20 ppm Avoparcin.

The influence of the antibiotic on the mineral components of the blood was negligible and only the level of inorganic P varied. The data concerning inorganic P obtained in both experiments were divergent, hence as in chicks (Jamroz et al., 1992) a lability of phosphorus concentration in the blood of laying hens was observed.

In literature, attention has been directed to the negative effect of antibiotics on egg lysozyme (Bogdanov and Jeleva, 1991; Bessei et al., 1993), and the positive effect on the egg shell (Jamroz et al., 1984; Tüller, 1991, 1969; Zgłobica et al., 1985). The parameters of egg quality in experiment A were stable, so no conclusion about the effect of addition of antibiotics to the feed is substantiated. In experiment B, however, the antibiotic significantly improved the strength of the shell (by 10 and 9%) and its thickness. These results correspond with the higher level of phosphorus found in the blood. It is worth noting that improvement in the quality of the shell was obtained in the experiment conducted during a long heat wave.

Microbiological tests did not show inhibition of *Bacillus subtilis* growth, or antibiotic activity in the egg matter, which proves that neither the antibiotic nor its metabolites were transferred into the eggs (Report, 1993).

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STRESZCZENIE

Zastosowanie Avoparcinu (Avotan) w żywieniu kur niosek

Przeprowadzono dwa doświadczenia na 192 kurach Tetra SL utrzymywanych w klatkach (A) oraz na 5340 nioskach Hisex Brown utrzymywanych na ściółce (B). Stosowane mieszanki zawierały 16 (A) lub 18% (B) białka ogólnego i średnio 11,2 MJ EM/kg. Grupy doświadczalne otrzymywały dodatek 5 i 10 (A) lub 10 i 20 ppm Avoparcinu (B). Badano wskaźniki nieśności, zmiany w pobraniu paszy, masie i jakości jaj, wytrzymałości skorupy oraz koncentrację Ca, P i Mg w surowicy krwi kur.

Dodatek do mieszanki 5 lub 10 ppm Avoparcinu w doświadczeniu A nie wpłynął na nieśność, która we wszystkich grupach wyniosła średnio 85,7%. W doświadczeniu B nieśność wzrosła o 18% po podaniu 10 ppm, o 6% po podaniu 20 ppm Avoparcinu.

Poprawę zużycia paszy na 1 jajo (o 6%) oraz wytrzymałości skorupy (o 10%) uzyskano jedynie przy dawce 10 ppm Avoparcinu w doświadczeniu B. Dodatek antybiotyku nie wpłynął na składniki mineralne krwi, zmienność obserwowano jedynie w poziomie P- nieorganicznego w surowicy krwi.