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PERFORMANCE INDICATORS, HEALTH STATUS AND COCCIDIAL INFECTION RATES IN RABBITS FED DIETS SUPPLEMENTED WITH WHITE MUSTARD MEAL

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Abstract

The objective of this study was to investigate the option of replacing chemical coccidiostats with finely ground white mustard (*Sinapis alba*) seeds in diets fed to broiler rabbits. Pelleted feed for control group animals (C) contained no coccidiostats. The diet for the first experimental group (E1) was supplemented with the chemical coccidiostat robenidine, and the diet for the second experimental group (E2) rabbits was supplemented with mustard meal. The experimental material comprised 90 F_1 hybrid rabbits (New Zealand White females × Flemish Giant males). The animals were fattened from 7 to 17 weeks of age. The body weight and average daily gains were recorded. Blood samples were collected for morphological and biochemical analyses, and oocyst counts in 1 g of rabbit feces were determined. Dressing percentage was calculated at the completion of the experiment. A free-choice palatability test carried out prior to fattening confirmed the satisfactory palatability of diets supplemented with mustard meal. Performance indicators, health status and coccidial infection rates were similar in the experimental groups (E1 and E2) fed diets supplemented with the chemical coccidiostat robenidine and mustard meal. In group C, production results were less favourable and coccidial oocyst counts in feces were higher.

Key words: rabbit, nutrition, coccidiostat, white mustard (*Sinapis alba*)

Organic food production is the leading trend in commercial farms supplying animal products intended for human consumption, including rabbit meat. Suppliers increase efforts to eliminate antibiotics and chemical coccidiostats from feed. Attempts have been made to replace chemical compounds with natural feed additives containing plant products as active substances. Various authors have investigated the effects of the following natural additives on production results and the health condition of rabbits: onion, garlic, oregano, bananas, supplements containing biologically active compounds found in the above plant species (El-Wafa et al., 2002; Ismail et al., 2003; Matekaire et al., 2005; Rahman and Nada, 2006; Gugołek et al., 2008; Simonova et al., 2008) and herbal additives (Das and Bora, 2004; Gugołek et al., 2006; Zhuang et al., 2007).

White mustard (*Sinapis alba*) is one of the many plants of the family *Brassicaceae* that deliver health benefits. White mustard seeds contain sinapine, a protoalkaloid, and sinalbin, an isothiocyanate glycoside, which exhibit biological activity (Josefsson and Uppstrom, 2006). Mustard seeds are characterized by a pungent taste and aroma, they stimulate the secretion of gastric juice and enhance digestion. They are the main component of mustard, a popular condiment. In folk medicine, mustard seed extracts were used mainly in the treatment of gastric ailments (Liu et al., 2005). To date, mustard seeds have not been used in rabbit nutrition. They have been administered to birds as a substitute for soybeans rather than a health additive (Slominski et al., 1999).

The health status of rabbits affects their immune response to various pathogens, including coccidia. Coccidial infections pose a sanitary problem and they lower the performance of farmed rabbits (Pakandl and Hiaiskova, 2007). The degree of coccidial invasions is determined not only by natural immunity, but also by the applied nutritional regime and housing conditions (Gugołek et al., 2006; Rahman and Nada, 2006; Zhuang et al., 2007; Nosal et al., 2009).

The objective of this study was to determine whether the replacement of a chemical coccidiostat with finely ground mustard seeds in diets for growing rabbits affects their productivity, health status and coccidial infection rates.

Material and methods

The experiment into the use of a herbal coccidiostat comprising mustard meal (*Sinapsis alba*) was carried out in a commercial rabbit farm in north-eastern Poland in the summer. The animals were kept indoors, in cages with a wire mesh floor, equipped with automatic feeders and drinkers. Cages had the following dimensions: height – 0.4 m, width – 0.45 m, length – 0.7 m, mesh size – 20×20 mm. Three animals were kept per cage. The rabbits were administered pelleted feed with the following percentage chemical composition: dry matter – 87.0, crude ash – 8.0, total protein – 16.0, crude fat – 3.2, crude fibre – 16.0, N-free extractives – 43.8. The energy value of 1 kg of feed was 2325 MJ. The feed for control group (C) animals contained no coccidiostats. The diet for the first experimental group (E1) was supplemented with the chemical coccidiostat robenidine, in the amount of 6 kg/t. The second experimental group (E2) was fed a diet supplemented with finely ground white mustard seeds in the amount of 1% feed weight.

The experimental material comprised F_1 hybrid rabbits (New Zealand White females × Flemish Giant males), the offspring of 3 males and 15 females. This type of crossing is used to produce heavier carcasses (Zając, 2004). A total of 90 animals were selected from the group of rabbits weaned at 7 weeks of age, taking into account their gender and origin. The rabbits were divided into three groups, each of 30 animals, with an equal number of males and females. Rabbits were fattened from 7 to 17 weeks of age. Body weight was measured accurate to 1 g using an electronic scale, and average daily gains were recorded at two-week intervals. Prior to fattening, 10 adult New Zealand White females were subjected to a free-choice palatability test to determine whether the addition of mustard meal affects diet palatability. Over a period of 20 days, the animals had a choice between feed containing no coccidiostats and feed supplemented with white mustard meal and robenidine. The quantity of alternatively ingested feed was registered on the last 10 days of the test.

Towards the end of the experiment, blood samples were analysed to determine the health condition of animals. Five ml of blood was collected from the auricular vein of five males and five females, selected randomly from each group. Blood samples were analysed using standard methods to determine the following morphological parameters: white blood cell counts (WBC), red blood cell counts (RBC), haemoglobin concentrations (HGB), haematocrit values (PVC), platelet counts (PLT), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentrations (MCHC) and red blood cell distribution width (RDW). Differential white cell counts were determined with a division into lymphocytes (LYM), monocytes (MON) and granulocytes (GRA). The following blood serum biochemical parameters were determined: glucose (GLU), total cholesterol (T.CHO), HDL-cholesterol (CHO-HDL) and triglyceride (TRG) levels. Blood morphological parameters were determined with the use of the Vet abc™ animal blood counter. Serum glucose levels were determined by the colorimetric method, using CORMAY Liquick Cor-GLUCOSE diagnostic kits (cat. no. 2–201). Triglyceride levels were determined using CORMAY Liquick Cor-TG diagnostic kits (cat. no. 2–253). Total cholesterol and HDL cholesterol levels were determined by the enzymatic-colorimetric method using CORMAY diagnostic kits.

In week 7, 13 and 17, oocyst counts in 1 g of rabbit feces were determined. To estimate coccidial infection rates, fecal samples of around 50 g were collected from under each cage, and the number of oocytes in 1 g of feces was calculated. Coproscopic examinations were carried out by the modified McMaster method involving initial centrifugation. Flotation solution was saturated sodium chloride and sugar. The species of coccidia were determined from sporulated oocysts. Coccidia were identified to the species level based on the size and morphology of oocysts and sporocysts (Pastuszko, 1963). The species of *Eimeria* were identified at 13 weeks of age.

Fattening ended in week 17, and the animals were slaughtered, skinned and eviscerated. Dressing percentage was calculated as follows: the weight of a decapitated and eviscerated carcass was divided by the animal's live weight and multiplied by 100.

The results were processed statistically by a one-factor analysis of variance in an orthogonal and non-orthogonal design (Statistica, 2007), or were shown in percentage terms.

Results

The results of feed palatability tests (Table 1) clearly indicate that rabbits willingly consumed feed without coccidiostats and diets supplemented with chemical and herbal coccidiostats. There were no significant differences in feed intake between groups.

Table 1. Diet palatability

Statistical measure	Daily feed intake n = 10		
	C	E1	E2
mean±SD (g)	51.16±8.11	49.93±9.56	48.91±10.13
%	34.11	33.28	32.61

No statistically significant differences were noted.

The key performance indicators of rabbits are shown in Tables 2 and 3. It was found that the alternative administration of a standard dose of the chemical coccidiostat robenidine and finely ground mustard seeds did not affect the performance of growing rabbits. The final body weights of group C animals were insignificantly lower, compared with experimental groups, due to lower daily gains at the end of fattening. Higher culling rates were also noted in group C.

Table 2. Body weight and dressing percentage of rabbits (mean±SD)

Age (weeks)	Body weight (g)		
	C	E1	E2
7	991.32±101.22	997.31±108.07	993.53±109.83
9	1368.01±138.38	1393.76±142.76	1379.88±138.65
11	1762.20±181.54	1774.72±175.92	1772.65±170.27
13	2216.79±198.91	2235.75±191.38	2239.96±180.11
15	2631.32±256.81	2646.63±254.33	2652.83±238.55
17	2791.24±264.33	2871.58±257.02	2843.13±256.16
Dressing percentage	50.56±1.73	50.84±1.75	50.44±1.76

No statistically significant differences were noted.

Table 3. Daily gains of rabbits (mean±SD)

Age (week)	Daily gains (g)		
	C	E1	E2
7–9	26.91±5.80	28.33±5.82	27.65±5.74
9–11	27.88±8.32	27.21±8.39	28.07±7.20
11–13	32.42±4.59	32.18±4.60	33.38±4.64
13–15	29.37±11.21	29.35±10.60	29.49±11.39
15–17	12.92±8.61	16.06±8.26	13.63±8.50
7–17	25.30±7.57	26.63±7.53	26.44±7.49

No statistically significant differences were noted.

Table 4. Evaluation of the health status of rabbits (mean±SD)

Item	C	E1	E2
Mortality rate (%)	10.00	3.33	3.33
Morphological blood parameters			
WBC (109/l)	8.11±0.67	8.36±0.50	9.28±0.89
RBC (1012/l)	6.72±0.81	6.68±0.77	5.57±0.69
HGB (mmol/l)	8.09±0.65	8.19±0.73	8.44±0.66
PCV (l/l)	0.39±0.05	0.37±0.06	0.38±0.06
PLT (109/l)	270.39±19.38	261.21±22.27	264.97±18.55
MCV (fl)	77.38±5.06	76.07±4.14	77.91±5.72
MCH (pg)	27.32±4.01	26.78±2.30	24.22±3.88
MCHC (g/dl)	37.39±4.22	36.11±4.31	36.33±4.19
RDW (%)	13.15±1.83	13.78±1.87	13.56±1.95
Biochemical blood parameters			
GLU (mmol/l)	6.28±0.92	6.36±0.81	5.95±0.81
T.CHO (mmol/l)	1.23±0.35	1.22±0.28	1.41±0.36
CHO-HDL (mmol/l)	0.41±0.10	0.40±0.10	0.33±0.11
TRG (mmol/l)	0.66±0.15	0.65±0.14	0.65±0.16
Differential white cell counts			
LYM (%)	61.02±5.36	60.12±4.96	61.23±5.95
MON (%)	10.32±1.12	10.17±1.19	10.91±0.97
GRA (%)	30.86±3.91	31.61±4.00	31.15±3.82
Coccidia oocyst counts in 1 g of feces at the age of			
7 weeks	676.38±42.39	631.14±48.09	682.24±39.11
13 weeks	34 252.02±1205.28 A	32 050.01±1460.21 B	31 850.87±978.46 B
17 weeks	45 326.12±2126.21 A,a	44 460.68±2700.42 b	43 820.43±2289.15 B

A, B – values in column with different letters differ significantly ($P \leq 0.01$).
a, b – values in column with different letters differ significantly ($P \leq 0.05$).

Blood morphological parameters presented in Table 4 were similar in all groups. In group C, oocyst counts in feces samples tended to increase in week 13 and 17. Significant differences were observed in this respect between group C and groups E1 and E2 in weeks 13 and 17. Nutritional regime had no effect on the species composition of *Eimeria*. In all groups, *E. media*, *E. perforan* and *E. magna* accounted for approximately 70% of oocysts, while *E. piriformis*, *E. irresidua*, *E. exigua*, *E. flavescens* and *E. intestinalis* were isolated less frequently.

Discussion

The good palatability of mustard-supplemented diets is a pertinent observation in view of the findings of Diaz (2000) and Osakwe and Ekwe (2007) who demonstrated that rabbits have a highly developed sense of taste.

The body weights, daily gains and carcass dressing percentage values noted in this study are comparable with the findings of Zając (2004) and Bielański (2004) who studied rabbits in a similar environment. Zając (2004) investigated the same hybrids, while Bielański (2004) analysed the Giant Chinchilla breed whose body weight is similar to that of the examined hybrids. A small decrease in daily gains was noted between week 15 and 17, suggesting a slower growth rate in older animals. Interesting results were also obtained by Dhara et al. (2009) who studied the daily gains of New Zealand White and Gray Giant rabbits aged 30 to 90 weeks. The reported values, similar for both breeds (around 26.5 g per day), are consistent with those observed in our experiment. It should be stressed, however, that the daily gains of intensively fed rabbits of synthetic lines and New Zealand White rabbits could be higher (Mugnai et al., 2008). The dressing percentage of rabbits was marginally higher than 50%. Similar results were obtained by Zając (2004). A slightly lower dressing percentage (46.9% – 48.9%) of Soviet Chinchilla and Gray Giant rabbits slaughtered at the body weight of 2188 – 2319 g was reported by Ghosh and Mandal (2008).

The blood morphological and biochemical parameters of rabbits were similar to those reported by other authors who analysed the blood profile of young broiler rabbits (Olayemi and Nottidge, 2007; Archetti et al., 2008). In the present study, there were no significant differences in morphological parameters between groups. Selected biochemical parameters and WBC counts also indicate that the applied feed additive had no effect on the health status of animals. Blood biochemical parameters were also measured by Simonova et al. (2008) who reported glucose levels of 5.0 to 6.8 mmol/l and cholesterol levels of 0.8 to 3.7 mmol/l. Differential white cell counts were typical and comparable to the findings of Archetti et al. (2008).

Coccidial infection rates are determined by housing conditions and the nutritional regime. The lowest infection rates are observed in cages with wire mesh floors, while the highest severity of infection is reported in traditional, litter-based housing systems (Gugołek et al., 2006; Sadzikowski et al., 2008, Nosal et al., 2009). Yet in many cases coccidial infection rates are not correlated with production results. In rabbits whose overall health is good, high oocyst counts in fecal samples do not have to be accompanied by a drop in performance. Coccidial infection rates expressed by oocyst counts in 1 g of feces were similar to those reported by Nosal et al. (2009) for comparable production conditions. The above authors found 11 000 – 28 000 oocysts in 1 g of feces collected from young rabbits. Similarly as in our study, oocyst counts increased with age. Lower oocyst counts than noted in our experiment were observed by Simonova et al. (2008). In the cited study, the administration of a natural feed additive substantially reduced oocyst counts, from 1435 to 217 in 1 g of fecal samples collected from 10-week-old rabbits. A similar *Eimeria* species was found by Sadzikowski et al. (2008) in rabbits from south-eastern Poland.

The results of this study indicate that diets supplemented with 1% mustard meal were characterized by satisfactory palatability. The performance indicators and health condition of rabbits, with special emphasis on coccidial infection rates, were similar in groups E1 and E2 fed diets supplemented with the chemical coccidiostat robenidine and mustard meal. In group C, production results were less favourable and coccidial oocyst counts in feces were higher.

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Wskaźniki użytkowe, stan zdrowotny i poziom zarażenia kokcydiami u królików żywionych paszą zawierającą rozdrobnione ziarna gorczycy

STRESZCZENIE

Celem badań było zbadanie możliwości zastąpienia chemicznego kokcydiostatyku rozdrobnionymi ziarnami gorczycy w żywieniu królików mięsnych. Grupa kontrolna (C) otrzymywała paszę granulowaną bez dodatku kokcydiostatyku. Pasza zwierząt grupy eksperymentalnej pierwszej (E1) zawierała chemiczny kokcydiostatyk – robenidynę, natomiast grupa eksperymentalna druga (E2) otrzymywała dodatek gorczycy. Materiał doświadczalny stanowiło 90 królików mieszańców F_1 (samice rasy nowozelandzki biały × samce olbrzym belgijski). Zwierzęta były tuczone w okresie od 7. do 17. tygodnia życia. Kontrolowano masę ciała i przyrosty dobowe królików. Przeprowadzono analizę morfologiczną i biochemiczną krwi oraz oznaczono liczbę oocyst kokcydii w 1 g kału. Po zakończeniu tuczu obliczono wydajność rzeźną. Przed tuczem przeprowadzono test smakowitości metodą wolnego wyboru, który wykazał zadowalającą smakowitość paszy z dodatkiem rozdrobnionej gorczycy. Badane parametry użytkowe, zdrowotność i stopień zarażenia kokcydiami były zbliżone w obu grupach eksperymentalnych (E1 i E2). W grupie C wyniki produkcyjne były niższe, a poziom kokcydii w kale wyższy.