The effect of phytogenic feed additives on the performance, meat quality and coccidial infection rates of rabbits

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ABSTRACT
The aim of the study was to evaluate the effect of herbal supplementation on rabbits’ health and production parameters. In experiment with herbal food additives, at 90 days of age animals fed with phytogenic additives (oregano, garlic and rosemary) had higher body weight compared to the group fed with coccidiostat. In experiment with herbal water additives (garlic extract or oregano) the phytobiotic supplementation had no effect on weight gains of animals. The highest body weight on slaughter day was obtained by rabbits drank water with garlic extract. Parasitological tests performed at 91 days of age showed that lowest average number of coccidia oocysts per gram of faeces (OPG) in “garlic” group (48.0 OPG) and the highest in control group (308.6 OPG). The research showed that feed with herbal supplementation is willingly eaten by rabbits, contributes to faster weight gains and has a positive effect on meat quality.

Key words: Coccidiostat, Garlic, Oregano, Phytogenic additives, Rabbit nutrition, Rosemary.

INTRODUCTION
In the rabbit meat production the use of antibiotics and chemical coccidiostats has been viewed critically because of their impact on the development of resistant bacteria and coccidia (Maertens et al., 2006; Pakandl, 2009). Producers step up efforts to eliminate antibiotics and chemical coccidiostats from feed. This has led to the appearance of different replacements such as probiotics, prebiotics, organic acids, enzymes, immune modulators and phytobiotics.

Effect of phytobiotics depends on their bioactive compounds. The most commonly used spices, oregano, savory and thyme are known to have antibacterial effects, due to their main active compounds, like thymol, carvacrol, p-cymene and g-terpinene (Nevas et al., 2004). Essential oil from plant extracts has distinct biological functions, such as antimicrobial, antifungal or antioxidant activities (Lee and Ahn, 1998). Recent in vivo studies have shown that adequate supplementation of growing rabbits with phytogenic additives, can exert a positive effect on productive performance, meat quality and protection against lipid oxidation (Cardinali et al., 2015).

Additionally, garlic extracts have been shown to have antioxidant activity in various meat types (Yin and Cheng, 2003; Tang and Cronin, 2007). Lipid oxidation is a major cause of quality deterioration in meat and meat products and can give rise to rancidity and the formation of undesirable odours and flavours, which affect the functional, sensory and nutritive values of meat products (Gray et al., 1996).

The objective of this study was to evaluate the effect of herbal supplementation on the performance, meat quality and coccidial infection rates in rabbits.

MATERIALS AND METHODS
Experiment I – Herbal feed additives: The study was carried out in the Experimental Station of the National Research Institute of Animal Production in Chorzelow (Poland).

Forty-eight New Zealand rabbits at the age of 90 d were randomly selected from the commercial herd, divided into four groups at the beginning of feeding period:
Group 1 (N=12) – males fed with pellets, supplemented with herbal concentrate based on garlic, oregano and rosemary (1 g concentrate per 1000 g of feed),
Group 2 (N=12) – females fed with pellets, supplemented with herbal concentrate based on garlic, oregano and rosemary,
Group 3 control (N=12) – males fed with commercial pellets, with a coccidiostat (E758 robenidine hydrochloride 62.7 mg/kg),
Group 4 control (N=12) – females fed with commercial pellets, with a coccidiostat.

Animals were group housed in cages (4 animals per cage), and fed ad libitum until the end of the trial. The pellet composition was 9.6 MJ/kg digestible energy, 87% dry matter, 17.04% crude protein, 2.63% crude fat, 13.5% crude fibre, 8.22% ash, 0.86% lysine, 0.43% methionine, 1.00% calcium, 0.29% sodium, 0.86% phosphorus. At the end of the feeding period (91d) animals were weighed.

After 24-h feed withdrawal animals were slaughtered in an experimental slaughterhouse in accordance with the current methodology. Sensory evaluation of meat was performed on the longissimus dorsi muscle. The muscle was matured at 4°C for three days. Samples were heated in water (0.6% NaCl solution) to mild boiling (one part of muscle to two parts of water) to an internal temperature of 85°C. Thermally treated meat was cooled under cover to room temperature, sliced and evaluated. The evaluation was performed by a panel of 5 assessors with previous sensory evaluating experience. Sensory analysis included the evaluation of meat colour, texture, aroma, tenderness, juiciness and palatability on a 5-point scale (Baryłyko-Pikielna and Matuszewska, 2009).

Experiment II – Herbal water additives: The study was carried out in the Experimental Centre at the Faculty of Animal Sciences of the University of Agriculture in Krakow (Poland).

Forty-eight New Zealand rabbits (males:females 1:1) were randomly divided into four groups at the weaning stage (42 d of age), group housed in cages (6 animals per cage), and fed ad libitum until the end of the experiment (91 d of age). In order to meet the nutrient requirements of the rabbits the basal fodder was commercial pellet - crude protein, 14.90%, crude fat, 4.50%, crude fibre, 17.30%, ash, 7.00%, lysine, 0.73%, methionine, 0.30%, calcium, 0.90%, sodium, 0.20%, phosphorus, 0.59%.

The experiment used herbal products: concentrated extract of garlic (composition: maltodextrin, natural oil of garlic; 1g of extract = 3g of dried garlic), at a dose of 0.5 g/litre of water; oregano powder concentrate (composition: maltodextrin, oregano oleoresin, oregano extract; 1g of concentrate = 3g of dried oregano), at a dose of 0.5 g/litre of water.

Control group (N=12) – fed with pellets, without the addition of a coccidiostat + drinking water without additives.

Group A (N=12) – fed with pellets, with the addition of a coccidiostat (E758 robenidine hydrochloride 65 mg/kg) + drinking water without additives.

Group B (N=12) – fed with pellets, without the addition of a coccidiostat + drinking water with garlic extract (Bellako – 14319).

Group C (N=12) – fed with pellets, without the addition of a coccidiostat + drinking water with oregano extract (Bellako – 14295).

The weight of rabbits was recorded once a week during the whole experimental period.

At the end of the 49-day feeding period, after 24 h fasting rabbits were weighed and slaughtered in an experimental slaughterhouse. The carcasses were prepared by removing the skin, feet, paws, genital organs, urinary bladder, and digestive tract. Carcasses with heads were weighed and the values were recorded and expressed as a dressing out percentage (%).

The test for Eimeria sp.: The tests for Eimeria sp. infection were carried out at the Laboratory of Parasitology in the Department of Zoology and Ecology, Institute of Animal Sciences, University of Agriculture in Krakow.

Samples of faeces were collected for analysis four times at 49, 63, 77 and 91 days of rabbits’ age. Coproscopy was performed according to a modified McMaster technique with faecal centrifugation, using saturated salt and sugar solution as flotation liquid. Coccidia species were identified based on measurements and morphology of oocysts and sporocysts, after sporulation in 2% potassium dichromate solution (Coudert et al., 1995).

After the slaughter of rabbits at 91 days of age, liver and intestine were examined for pathological changes (Kostro and Gliński, 2005).

Statistical analysis: Statistical analyses were performed using Statistica 10 (StatSoft 2011) using General Linear Model procedure. In experiment I effects of sex and fodder were included as well as interaction between sex and fodder. In experiment II effect of sex and fodder were included. Differences amongst groups were evaluated with Tukey’s test at P≤0.05. The sex and the interaction between sex and fodder were not statistically significant.

RESULTS AND DISCUSSION

Dietary treatments with herbal food additives significantly affected the productive performance of growing rabbits (P<0.05) (Table 1). Slaughter weight (SW) was consistently different among groups at the end of the trial (P<0.05). Animals fed with phytoogenic additives had higher SW (2.735 kg, SE=0.044) compared to the group fed with standard fodder with coccidiostats (2.327 kg, SE=0.037). The sex and the interaction between sex and fodder were not statistically significant.

The sensory evaluation indicated significant differences (P<0.05) in colour, aroma and palatability of meat of rabbits fed with pellets supplemented with phytogenic
additives in comparison to meat of rabbits fed with pellets supplemented with coccidiostat. Non-significant results were found for the meat texture, tenderness and juiciness (Table 2). The meat quality attributes are affected by the quantity and quality feed and fodder. The close relationship between diet and health has lead to changes in consumer habits, demanding products that meet their dietary and nutritional preferences. Rabbit meat is highly valued for its nutritional and dietary properties, it is a lean meat with a low-fat content and less saturated fatty acids and cholesterol than other meats. Rabbit meat consumption could improve bioactive compounds to human consumers, since manipulation of rabbit's diet is very effective in increasing the levels of ω3 PUFA, CLA or Vitamin E (Ruban et al., 2010).

The phytobiotic water supplementation had no adverse effect on weight gains of animals from weaning to 91 days of age. Mean weekly weight gain amounted to 210.5 g/week. The highest body weight on slaughter day was 91 days of age. Mean weekly weight gain amounted to 210.5 g/week. The highest body weight on slaughter day was obtained by rabbits in group B. Group C and groups A and B were significantly different (P<0.05). For comparison, Ratika et al. (2016) were feeding broiler chickens with additives of garlic powder and observe that incorporation of 3% garlic powder in chicken diet improved growth performance and significantly improve meat quality.

Highest dressing out percentage (60.7%) was noted in rabbits from group C, and lowest (59.7%) in rabbits from group A (Table 3), what was relatively high. After taking into account the average weight of the head (160g) and subtracting it from the carcass (Chwastowska-Siwiecka et al., 2011), the average dressing out percentage was 54%. Similar results were obtained by Kowalska et al. (2012), where depending on the herbal supplement, the dressing out percentage varied from 52.7 to 55.9%. Results of studies carried out on New Zealand rabbits suggested that different proportions of feed additives based on natural oregano and garlic oils, added to complete diets, had a positive effect on the weight gains of rabbits (Kowalska et al., 2012).

Parasitological tests for Eimeria sp. performed at 49 days showed that most rabbits presented low infection with coccidia. The mean number of oocysts per gram of faeces (OPG) was 971 (ranging from 280 to 1504 OPG). At the last sampling (91 days of age), the lowest number of coccidia oocysts was found in group B (48 OPG) and the highest in Control group (308.6 OPG) (Table 4). Post mortem examination of the liver and intestine revealed no pathological changes characteristic of coccidiosis.

Results of the research showed the possibility of using herbal supplements such as rosemary, garlic and oregano in rabbit nutrition. Currently research is carried out to determine the effect of coccidia infection in many species. Similar research on the use of oregano demonstrated that in 14-day-old broiler chickens infected with Eimeria tenella, which were fed with oregano oil showed faster growth after 2 weeks with incidences of bloody diarrhoaeas and greater survival compared to untreated individuals (Giannenas et al., 2003). Saini et al., (2003) demonstrated that oregano oil added to broiler feed has similar activity to salinomycin – a strong coccidiostatic, antitumor and antibacterial agent with improved breeding parameters and decreased death rate. Properly formulated rations of the concentrates reduced the intensity of coccidial infections while protecting the animals against secondary bacterial and viral infections, which usually accompany coccidiosis and are a common cause of mortality (Kowalska et al., 2012).

Herbal supplements are not only an important dietary component that helps to prevent and eliminate

### Table 1: Slaughter weight at 91-day New Zealand rabbits, fed with pellets with addition of herbs or coccidiostats.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>SW</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>12</td>
<td>2.805 *</td>
<td>0.062</td>
</tr>
<tr>
<td>G2</td>
<td>12</td>
<td>2.665 *</td>
<td>0.058</td>
</tr>
<tr>
<td>G3</td>
<td>12</td>
<td>3.312 b</td>
<td>0.059</td>
</tr>
<tr>
<td>G4</td>
<td>12</td>
<td>2.342 b</td>
<td>0.048</td>
</tr>
</tbody>
</table>

Different letters indicate statistically significant differences (P<0.05).

SE - standard error, SW – slaughter weight at 91-day, G1 – males fed with pellets, supplemented with herbs additives, G2 – females fed with pellets, supplemented with herbs additives, G3 – control group, males fed with pellets, with the addition of a coccidiostat, G4 – control group, females fed with pellets, with the addition of a coccidiostat

### Table 2: Mean values of sensory evaluation of meat (0 – lowest score, 5 – highest score) from rabbits fed with pellets, with the addition of a coccidiostat or herbs additives.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Colour</th>
<th></th>
<th></th>
<th>Texture</th>
<th></th>
<th></th>
<th>Aroma – intensity</th>
<th></th>
<th></th>
<th>Aroma – desirability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SE</td>
<td></td>
<td>Mean</td>
<td>SE</td>
<td></td>
<td>Mean</td>
<td>SE</td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Coccidiostats</td>
<td>50</td>
<td>4.04 a</td>
<td>0.090</td>
<td>3.92</td>
<td>0.100</td>
<td>3.46 a</td>
<td>0.091</td>
<td>3.50 b</td>
<td>0.091</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbs</td>
<td>50</td>
<td>4.38 b</td>
<td>0.080</td>
<td>4.12</td>
<td>0.102</td>
<td>4.04 b</td>
<td>0.103</td>
<td>4.18 b</td>
<td>0.089</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tenderness</td>
<td>Juiciness</td>
<td></td>
<td>Palatability-intensity</td>
<td></td>
<td></td>
<td>Palatability-desirability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SE</td>
<td></td>
<td>Mean</td>
<td>SE</td>
<td></td>
<td>Mean</td>
<td>SE</td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Coccidiostats</td>
<td>50</td>
<td>3.78</td>
<td>0.096</td>
<td>3.76</td>
<td>0.113</td>
<td>3.42 b</td>
<td>0.081</td>
<td>3.56 b</td>
<td>0.086</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbs</td>
<td>50</td>
<td>4.02</td>
<td>0.101</td>
<td>3.72</td>
<td>0.111</td>
<td>4.08 b</td>
<td>0.103</td>
<td>4.46 b</td>
<td>0.100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Different letters within the same trait indicate statistically significant differences (P<0.05).

SE - standard error
coccidia, but they are also willingly eaten. The research done in 2012 (unpublished data) concerned the taste preferences of rabbits regarding some herb supplements added to drinking water. Quantity of water drunk showed that rabbits especially like oregano, but there are some individuals with other taste preferences or ones without strong preferences.

Herb supplementation causes better palatability, colour and aroma of rabbit meat. It is more often chosen by consumers. There are plenty of research that shows different possibilities of improve the sensory attributes of rabbit meat, for example supplementation with 2% yeast (Khanna et al. 2015). Another research showed that oregano oil added to rabbit feed reduces the growth of microorganisms in chilled carcasses. It also contributes to decreasing the smell of rot in 8- and 10-day-old carcasses and improves storability.

To sum up the research, it could be concluded that feed supplemented with herbs is willingly eaten by rabbits and contributes to faster weight gains. In organoleptic tests, consumers prefer the meat of rabbits fed with herbal supplementation.

ACKNOWLEDGMENT

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REFERENCES


Table 3: Slaughter weight (91 d), carcass weight and dressing out percentage of rabbits.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>SW (kg)</th>
<th>SE</th>
<th>Carcass kg</th>
<th>SE</th>
<th>DP</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>12</td>
<td>2.653*</td>
<td>0.069</td>
<td>1.591</td>
<td>0.034</td>
<td>60.0</td>
<td>0.494</td>
</tr>
<tr>
<td>Gr. A</td>
<td>12</td>
<td>2.691a</td>
<td>0.050</td>
<td>1.604</td>
<td>0.022</td>
<td>59.7</td>
<td>0.468</td>
</tr>
<tr>
<td>Gr. B</td>
<td>12</td>
<td>2.706*</td>
<td>0.055</td>
<td>1.625</td>
<td>0.031</td>
<td>60.1</td>
<td>0.367</td>
</tr>
<tr>
<td>Gr. C</td>
<td>12</td>
<td>2.511ab</td>
<td>0.048</td>
<td>1.525</td>
<td>0.033</td>
<td>60.7</td>
<td>0.393</td>
</tr>
</tbody>
</table>

Different letters within the same column indicate statistically significant differences (P<0.05).

SE - standard error, SW - Slaughter weight (91 d), DP - dressing out percentage.

Table 4: Coccidia infection status of rabbits (oocysts per gram of faeces – OPG)

<table>
<thead>
<tr>
<th>Days of age</th>
<th>49d</th>
<th>63d</th>
<th>77d</th>
<th>91d</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>OPG</td>
<td>SE</td>
<td>N</td>
<td>OPG</td>
</tr>
<tr>
<td>Control</td>
<td>5</td>
<td>280.0</td>
<td>39.5</td>
<td>5</td>
</tr>
<tr>
<td>Gr. A</td>
<td>5</td>
<td>960.0</td>
<td>232.5</td>
<td>5</td>
</tr>
<tr>
<td>Gr. B</td>
<td>5</td>
<td>1140.0</td>
<td>758.0</td>
<td>5</td>
</tr>
<tr>
<td>Gr. C</td>
<td>5</td>
<td>1504.0</td>
<td>201.6</td>
<td>5</td>
</tr>
</tbody>
</table>

Different letters within the same column indicate statistically significant differences (P<0.05).

SE - standard error


