Effect of prebiotic feed supplement on the performance and carcass yield of broilers Ross

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Abstract

The study evaluates the effects of the prebiotic „Actigen®" on the growth and development of ROSS broilers and the possibility to exclude antibiotics during the fattening period. To this end, 4 groups of male broiler chickens were formed: Group T1 – control group, fed standard feed, but water was supplemented with antibiotic; Group T2 – broilers received nothing but the standard feed, while water was not supplemented with an antibiotic; Group T3 – the feed of broilers was supplemented with a prebiotic (Actigen®) at 800 g/t in starter, 400 g/t in grower, 200 g/t in finisher, and water was supplemented with an antibiotic; Group T4 – feed of broilers was supplemented with prebiotic (Actigen®) at 800 g/t in starter, 400 g/t in grower, 200 g/t in finisher, whereas water was not supplemented with an antibiotic. It was found that during the first feeding phase, birds from groups T1, T3 and T4 had a statistically significantly higher weight gain compared to group T2. During the second phase, broilers from group T2 preserved the considerably lower weight gain, whereas during the third stage of feeding, group T3 demonstrated statistically significantly higher weight gain than both groups T1 and T2 ($P < 0.05$), hence the higher live weight gain of broilers from group T3 by the end of the experiment ($P < 0.05$). The best FCE (feed conversion efficiency) was established in groups T3 – Actigen® + antibiotic; T4 – Actigen® (without antibiotic) – 1.944 kg feed/kg gain and 2.059 kg feed/kg gain respectively. Data for mortality rate during the rearing period showed that no birds from group T4, supplemented with Actigen® but not supplemented with an antibiotic, have died. Highest mortality occurred in groups T1 and T2 – 8.7%, whereas the mortality rate in group T3 – Actigen® + antibiotic was 4.35%. Calculated EPEF was highest in group T3 – 299 and T4 – 280. In conclusion, chickens whose feed was supplemented with a prebiotic, had a higher final live weight, showed better feed conversion efficiency and higher European poultry efficiency factor (EPEF).

***Key words*:** broilers, meat protein content, prebiotic, productivity, slaughter traits

Introduction

The utilisation of antibiotics in poultry farming permits the emergence of antibiotic resistant bacterial strains, which are transferred to eggs and meat and pose various risks for the health of consumers. This necessitates using alternative supplements to replace antibiotics in poultry nutrition. An excellent alternative of antibiotics are pro- , pre- and synbiotic substances, which are beneficial for host organisms by enhancing the development of healthy intestinal microbial strains and elimination of pathogens. These preparations could be applied both in drinking water and in feed. Additional investigations are however needed to determine the appropriate dosage, as well as combinations of bioactive substance and optimal route of their administration. Prebiotics are non digestible feed ingredients that stimulate specific bacteria from the intestinal microflora, increasing the resistance to infections in hosts (Kim et al., 2019). The addition of prebiotics to poultry feeds not only improves their health, bit also promotes their growth (Ricke et al., 2020). It is reported that body weight was increased in most of studies (Yusrizal and Chen, 2003; Sims et al., 2004; Zduńczyk et al., 2005; Yuan-yuan Xing et al., 2020). Along with body weight increase, feed conversion and slaughter carcass weight are improved (Samarasinghe et al., 2003; Xu et al., 2003; Józefiak et al., 2008; Yang et al., 2008). Frequently used prebiotics are oligosaccharides, as fructooligosaccharides (FOS), mannan oligosaccharides (MOS), lactulose, inulin. They are widely used in animals to improve growth rate, increase milk yield, meat and egg production (Rai et al., 2013). Fermentable oligosaccharides are the most famous among prebiotics with increasing important in poultry farming. They act through different mechanisms, as provision of nutrients, prevention of adhesion of pathogens to host cells, interacting with host immune system and affecting intestinal morphology, most probably by intestinal microbiota modulation.

The aim of the study was to evaluate the effect of the prebiotic „Actigen® on the growth and development of broiler chickens and the possibility to exclude antibiotics and vitamins.

Material and Methods

The experiment was carried out in August-September 2018 with 4 groups of male ROSS broiler chickens. Each groups consisted of 25 birds housed in a box with area 2.4 m^2.

The fodder was offered in tray feeders during the starter period, and during the other two periods (grower and finisher) – in manual hanging feeders and automated drinkers.

During the experiment, the effect of the prebiotic „Actigen® on the growth and development of birds was tested. The prebiotic is a second-generation bioactive fraction from the cellular walls of a specific yeast strain, a mannan oligosaccharide.

All chickens were fed *ad libitum* the same complete starter (1–14 days), grower (15–35 days) and finisher (36–42 days) containing 23, 21 and 20% crude protein and 2999, 3081 and 3133 kcal metabolizable energy/kg, respectively. During rearing, body weight, feed intake and mortality were recorded.

The following groups of birds were formed:

- Group T1 – control group, birds were fed standard feed, but water was supplemented with antibiotic;
- Group T2 – birds received nothing but the standard feed, was not supplemented with antibiotic;
- Group T3 – feed of broilers was supplemented with prebiotic (Actigen®) at 800 g/t in starter, 400 g/t in grower, 200 g/t in finisher, and water was supplemented with antibiotic;
- Group T4 – feed of broilers was supplemented with prebiotic (Actigen®) at 800 g/t in starter, 400 g/t in grower, 200 g/t in finisher, water was not supplemented with antibiotic.

Slaughter analysis was performed on 12 broilers (3 from each group) with average body weight for the respective group. The live body weight was determined after 12-hour fasting, as well as grill weight, weight of body cuts (breast, thighs, and wings), edible offal (heart, liver, and gizzard) and abdominal fat content. On the basis of these data, slaughter yield was calculated.

Meat protein content was determined as per BSS 9374-82 for analysis of protein content in meat and meat products.

For integral evaluation of the broilers, the European poultry efficiency factor (EPEF) was calculated using the formula:

$$EPEF = \frac{\text{Live body weight (kg) x livability (\%) x 100}}{\text{Fattening period (days) x feed conversion (kg/kg)}}$$

Statistical analysis of differences between groups was done by means of Student t-test (Statistica, 2006).

Results and Discussion

In the beginning of the experiment, all groups were uniform with respect to average live weight gain and between-group differences were irrelevant (Table 1). By the end of the trial, broilers from group T3 – (Actigen® + antibiotic) were statistically significantly heavier than birds from groups T1 – (control + antibiotic) and T2 – untreated (no antibiotic) by 8.21% and 15.17% respectively. Group T4 – Actigen® (without antibiotic) had an average live weight of 2.451 kg which was statistically higher than average weight of birds from group T2 – untreated (no antibiotic) – 2.159 kg (11.91%). Studies of other researchers documented the beneficial impact on poultry performance and possibility of replacement of antibiotics with dietary prebiotics in broilers (Yang et al., 2009; Mateova et al., 2008; Patterson & Burkholder, 2003). Sohail et al. (2012) also found out that the addition of probiotics and prebiotics in the feed of broilers improved growth performance and increased live weight. Lea et al. (2011) affirmed that the used of Actigen®, at a dietary level of 200 g/t feed gave the best results for live weight (2847 g of experimental group vs. 2515 g in control group) and feed conversion of 1.73 kg/kg (experimental group) and 1.74 kg/kg (control group). The beneficial effect of Actigen® on production traits of broilers was confirmed also by Culver et al. (2011), Lausten et al. (2011) and Olejniczak et al. (2011).

The best feed conversion efficiency (FCE) values were obtained in group T3 – Actigen® + antibiotic and vitamins; T4 – Actigen® (without antibiotic): 1.944 kg feed/kg gain and 2.059 kg feed/kg gain. The high daily weight gain and the relatively low feed intake in birds from group T3 (Tables 1 and 2) were the cause for the good FCE of 1.994 kg (Table 1). Broilers from group T2 showed a relatively high feed intake per 1 kg gain, with difference vs. broilers from group T3 by 13% and 10% (Table 1). Mookiah et al. (2014) also demonstrated that the addition of prebiotic in feed resulted in higher average daily weight gain in broiler chickens and reduction of feed expenditure per 1 kg gain.

These results were in line with studies of Yang et al. (2009) showing that the intake of mannan oligosaccharide (MOS, Bio-MOS, Alltech Inc.) improved feed conversion in broiler chickens. This was due to the effect of healthy bacteria contained in prebiotics, which block the adhesion and colonisation of intestines by Gram-negative microbial pathogens and promote the replication of useful bacteria (lactic-acid bacteria and bifidobacteria); thus, the release of nutrients necessary for new tissue growth in intestines becomes more efficient and consequently, the immunity and productivity of the animal are increased (Spring et al., 2000; Sims et al., 2004; Baurhoo et al., 2007). Data about mortality during the rearing period showed that in group T4 (birds supplemented with Actigen® without antibiotic) no birds have died. The highest mortality rates were

Table 1. Live weight, daily weight, feed conversion, mortality and EPEFG of broilers during the experimental period

Parameters	T1	T2	T3	T4
- Live weight in the beginning of the experiment (kg)	0.042 ± 0.001 [a]	0.043 ± 0.001 [a]	0.043 ± 0.001 [a]	0.043 ± 0.001 [a]
- Live weight by the end of the experiment (kg)	2.336 ± 0.073 [b]	2.159 ± 0.073 [a]	2.545 ± 0.045 [c]	2.421 ± 0.081 [bc]
Daily weight gain (kg)	0.055 ± 0.001 [b]	0.050 ± 0.002 [a]	0.060 ± 0.002 [c]	0.057 ± 0.002 [bc]
Feed conversion (kg feed/kg gain)	2.122	2.296	1.944	2.059
Mortality (%)	8	8	4	-
EPEF	241	206	299	280

Abbreviations: T1 – control + antibiotic; T2 – untreated (no antibiotic); T3 – Actigen® + antibiotic; T4 – Actigen® (no antibiotic)

[a, b, c] *Differences marked with different superscripts are statistically significantly different at $P < 0.05$*

observed in groups T1 and T2 – 8%, whereas in Group T3 – Actigen® + antibiotic mortality was 4% (Table 1).

Calculated EPEF was the highest in groups T3 – 299 and T4 – 280 and significantly lower in group T1 – 241 and T2 – 206. This coefficient depends on the parameters of live weight at the end of the experiment, livability of birds, duration of fattening period and feed conversion. The obtained EPEF values in this trial proved that supplementation of the feed with prebiotic was economically justified in fattening broiler chickens. In an experiment, where the prebiotic was supplemented during the embryonic development of the experimental group, Bernarczyk et al. (2011) found out EPEF 304 for experimental and EPEF 311 for the control groups.

The results showed that during the starter period, broilers from group T4 consumed the highest amount of feed compared to groups T1; T2 and T3, where differences varied by 9.7%, 6.4% to 3.44%. During the finisher period, the opposite tendency in feed intake was noted: it was the lowest in group T4 than in all other groups (Table 2). Average feed consumption over the entire rearing period was similar in all four studied groups. In birds that received Actigen® plus antibiotic – group T3 – it was 119.63 g, followed by group T4 – Actigen® (without antibiotic) – 117.35 g, T1 – control plus antibiotic – 116.73 g and the lowest value of this parameter was found out in untreated birds without antibiotic from group T2 – 114.79 g. These results were similar to data of other researchers (Hooge et al., 2003 and Bozkurt et al., 2008) while another study of Salma et al. (2007) demonstrated that feed intake by broilers did not varied significantly when a probiotic was supplemented. Similar data were reported by Jung et al. (2008) e.g. lack of substantial effect on feed intake of broiler chickens after addition of prebiotic and probiotic. Our study was comparable to that of Salianeh et al. (2011) who reported that included prebiotic decreased considerably feed intake of broiler chickens compared to control group. Also, Xu & Gordon (2003) published that broilers supplemented with 0.4% FOS in their feed showed substantial improvement in average daily gain and feed efficiency compared with those fed under the control group.

During the first stage of feeding, birds from groups T1, T3 and T4 exhibited statistically higher weight gain compared to group T2 (Figure 1). During the second phase, the significantly lower weight gain in group T2 was preserved while during the third phase, birds from group T3 showed significantly higher weight gain vs. group T1 and T2 ($P < 0.05$) (Fig. 1), resulting in higher final live weight of birds at the end of the experiment ($P < 0.05$) (Table 2).

The slaughter analysis at the end of the experiment showed insignificant differences in absolute values of grill weight between groups T1, T2 and T3 (Table 3). This was in line with studied of Pelicia et al. (2004) having reported no differences in slaughter results in birds whose diets were supplemented or not with prebiotics. The highest values of this parameter was found in group T3 – 1.752 kg, followed by T1 – 1.675 kg, T4 – 1.665 kg and the lowest grill weight was in group T2 – 1.618 kg. This tendency was preserved for slaughter yield, being a derivative of live weight and grill weight. The highest slaugh-

Table 2. Average daily feed intake by broilers during the different phases of the experiment (g)

Phases	T1	T2	T3	T4
Starter	39.3	39.3	40.7	43.5
Grower	111.54	113.74	123.24	117.16
Finisher	199.34	199.32	194.95	191.40
Average for the period	116.73	114.79	119.63	117.35

Abbreviations: T1 – control + antibiotic; T2 – untreated (no antibiotic); T3 – Actigen® + antibiotic; T4 – Actigen® (no antibiotic)

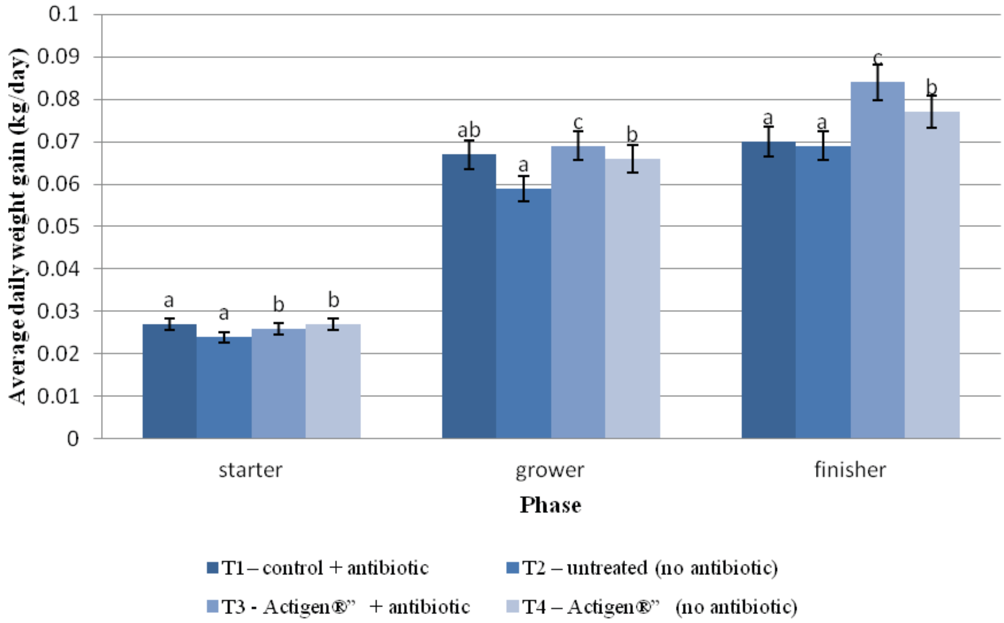

Fig. 1. Average daily weight gain during the different phase of the experiment (kg/day)

a, b, c Differences marked with different superscripts are statistically significantly different at P < 0.05

ter yield was established in birds from group T3 – 76.84% which was by 6.31% higher than group T2 (8.21%). The slaughter yield in groups T1 and T4 was 75.69% and 74.66% respectively. Narasimha et al. (2013) reported slaughter yield percentage between 63.67% and 66.67% in 42-day-old Cobb broilers. The slaughter yield (%) in Vencobb broilers supplemented with prebiotics in feed (Sarangi et al., 2016) showed variations of the trait from 73.77% to 76.04% at 42 days of age, which exceeds the values reported by Abdel-Raheemand & Abd-Allah (2011) – 64.45 to 70.68% in Avian – 48 broilers at the same age.

No statistically difference between groups was found out with regard to breast and ribcage weights in studied groups. Broilers from group T1 had the statistically lowest thigh weight ($P < 0.05$) whereas differences between the other 3 groups were insignificant. Abdominal fat values varied from 0.044 kg in T4, 0.040 kg in T3, 0.039 kg in T2 to 0.031 kg in T1 but differences were relevant only between group T2 – untreated (no antibiotic) and T4 – Actigen® (no antibiotic). These data disagree with those of Ashayerizadeh et al. (2009) reporting lower abdominal fat in broilers supplemented with Biolex® MB compared to control birds. However Brzóska et al. (2007) and Pelicano et al. (2005) did not found a significant effect on abdominal fat of carcass from the addition of MOS (Mannan oligosaccharide) and SC (Saccharomyces cerevisae) in rations of broiler chickens. A positive effect of dietary prebiotic on carcass quality was affirmed by Piray et al. (2007) while other researchers as Pelicia et al. (2004) found no differences in slaughter traits between birds supplemented or not with prebiotics through feed.

The analysis of meat protein content demonstrated statistically significantly higher protein content of breast of broilers from group T1 – 22.31% and T4 – 22.66% (Table 4). Relatively less protein was found out in the breast meat of birds from groups T3 – 21.22% and T2 – 21.02%. The thigh protein content of birds from all four groups was within the optimum range, with insignificant differences varying from 19.22% in group T3 to 18.28% in group T1. Increased meat protein content of birds supplemented with prebiotics was reported also by Král et al. (2013) whereas Brzóska et al. (2007) and Konca et al. (2009) affirmed that supplemented of MOS and

Table 3. Slaughter traits

Parameters	T1	T2	T3	T4
Live weight, kg	2.213 ± 0.057 [a]	2.294 ± 0.073 [a]	2.280 ± 0.060 [a]	2.230 ± 0.017 [a]
Grill weight, kg	1.675 ± 0.023 [ab]	1.618 ± 0.038 [ab]	1.752 ± 0.032 [b]	1.665 ± 0.029 [a]
Slaughter yield, %	75.69	70.53	76.84	74.66
Breast meat, kg *	0.552 ± 0.023 [a]	0.567 ± 0.012 [a]	0.595 ± 0.011 [a]	0.566 ± 0.012 [a]
Ribcage, kg	0.390 ± 0.009 [a]	0.397 ± 0.030 [a]	0.372 ± 0.022 [a]	0.367 ± 0.014 [a]
Thighs, kg	0.499 ± 0.011 [a]	0.546 ± 0.026 [b]	0.538 ± 0.010 [b]	0.569 ± 0.030 [b]
Wings, kg	0.185 ± 0.002 [a]	0.198 ± 0.002 [b]	0.200 ± 0.002 [b]	0.187 ± 0.006 [a]
Gizzard, kg	0.033 ± 0.001 [a]	0.034 ± 0.003 [ab]	0.031 ± 0.001 [a]	0.033 ± 0.001 [a]
Heart, kg	0.054 ± 0.042 [a]	0.012 ± 0.001 [a]	0.012 ± 0.001 [a]	0.010 ± 0.001 [a]
Liver, kg	0.045 ± 0.003 [a]	0.045 ± 0.003 [a]	0.046 ± 0.003 [a]	0.037 ± 0.003 [a]
Neck, kg	0.059 ± 0.004 [a]	0.058 ± 0.002 [a]	0.054 ± 0.003 [a]	0.057 ± 0.002 [a]
Abdominal fat, kg	0.031 ± 0.003 [ab]	0.039 ± 0.001 [a]	0.040 ± 0.003 [ab]	0.044 ± 0.006 [b]

Abbreviations: T1 – control + antibiotic; T2 – untreated (no antibiotic); T3 – Actigen® + antibiotic; T4 – Actigen® (no antibiotic)
[*] breast meat without skin
[a, b] Differences marked with different superscripts are statistically significantly different at P < 0.05

Table 4. Meat protein content, %

Parameters	T1	T2	T3	T4
Breast	22.31 [b]	21.02 [a]	21.22 [a]	22.66 [b]
Thigh	18.28 [a]	18.73 [a]	19.22 [a]	18.80 [a]
Average	20.29 [ab]	19.87 [a]	20.22 [ab]	20.73 [ab]

Abbreviations: T1 – control + antibiotic; T2 – untreated (no antibiotic); T3 – Actigen® + antibiotic; T4 – Actigen® (no antibiotic)
[a, b] Differences marked with different superscripts are statistically significantly different at P < 0.05

probiotics did not influence the crude protein content of meat in chickens and turkey poults.

Conclusions

In conclusion, the use of prebiotic and/or antibiotic in feeds of broiler chickens influenced significantly the productive performance of birds in this study. Chickens supplemented with prebiotic with feed had higher final live body weight, better feed conversion efficiency and higher European poultry efficiency factor (EPEF).

Therefore, the prebiotic product could be a potential alternative to conventional antibiotics in fattening broiler chickens under experimental conditions. Additional monitoring is necessary to determine the effects of prebiotics' supplementation for replacing antibiotics in the feed of broilers in an industrial setting.

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