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Synbiotics as functional additives in broiler diets: Production and slaughter performance

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A B S T R A C T

To enhance the safety and efficiency of broiler nutrition, this study investigated the effects of a synbiotic product containing both probiotic and prebiotic components, administered through drinking water. The experiment was conducted on 600 Cobb 500 broilers divided into control and treatment groups. Over a 42-day fattening period, key production parameters – including feed intake (FI), average daily gain (ADG), feed conversion ratio (FCR), and the European Production Efficiency Factor (EPEF) – as well as slaughter traits were monitored. Synbiotic supplementation significantly improved growth performance, feed efficiency, and overall production outcomes. A higher carcass yield and a trend toward an increased proportion of breast muscle were also observed in the treated group. The findings suggest that synbiotics can be a valuable functional additive in broiler production, contributing to improved growth and carcass quality without adverse effects on animal health.

Keywords: synbiotics, probiotics, prebiotics, production traits, slaughter traits

И З В О Д

У циљу унапређења безбедности и ефикасности исхране бројлера, у овом истраживању испитиван је ефекат синбиотичког препарата који садржи комбинацију пробиотских и пребиотских компоненти, примењеног путем воде за пиће. Оглед је спроведен на 600 бројлера хибрида Cobb 500, подељених у контролну и експерименталну групу. Током 42 дана това праћени су кључни производни параметри – унос хране (FI), просечан дневни прираст (ADG), конверзија хране (FCR) и Европски коефицијент производне ефикасности (EPEF) – као и кланичне особине. Суплементација синбиотиком је значајно побољшала производне резултате, искоришћеност хране и укупну ефикасност това. У групи која је користила синбиотик забележен је већи рандман трупа и изражен тренд повећања учешћа грудног мишића. Добијени резултати указују на то да синбиотици могу представљати вредан функционални додатак у исхрани бројлера, доприносећи бољем расту и квалитету трупа без негативног утицаја на здравље животиња.

Кључне речи: синбиотици, пробиотици, пребиотици, производне особине, кланичне особине

1. Introduction

In intensive poultry production, achieving high production performance while preserving animal health and food safety for the end consumer is a special challenge. Modern consumers and regulations increasingly demand the use of natural nutritional supplements, which contribute to the improvement of poultry performance without harmful residues in the products. In this context, special attention is drawn to functional additives such as probiotics, prebiotics and their combination – synbiotics (Falaki et al., 2011; Pourabedin and Zhao, 2015).

Probiotics are defined as live microorganisms that, when ingested in sufficient quantities, have a positive effect on the host's health, most often by stabilizing the intestinal microbiota, improving digestion and strengthening the immune response. In poultry production, the most commonly used bacterial strains include species of the genera Lactobacilli, Bifidobacterium and Bacillus that have shown effectiveness in suppressing pathogenic bacteria and improving intestinal morphology (Patterson and Burkholder, 2003; Teo and Than, 2006). Perić et al. (2010) showed in their research that the addition of probiotics to the diet of broiler chickens has a pronounced beneficial effect on the morphological characteristics of the jejunum, with a significant increase in the height and surface area of the intestinal villi in the group treated with probiotic.

On the other hand, prebiotics are indigestible food components that selectively encourage the growth of beneficial microorganisms, such as bifidobacteria and lactobacilli, in the gastrointestinal tract. This stimulation contributes to better fermentation, reduction of pathogenic flora and improvement of nutrient absorption (Hayati and Rezaei, 2010). They have the ability to modify biological processes in the

gastrointestinal tract of chickens, thus contributing to the improvement of production performance and preservation of poultry health (Yaqoob et al., 2021).

When probiotics and prebiotics are combined in a unique synbiotic formulation, a synergistic effect occurs: the prebiotic enables better colonization of probiotic bacteria and prolongs their effect in the digestive tract. This further improves the microbiological balance of the intestines, the efficiency of digestion and the immune response of the animal (Markowiak and Śliżewska, 2018). Current research indicates that the use of synbiotics in broiler diets can result in a significant improvement of production indicators – including increased daily gain, better feed conversion and a higher efficiency index, as well as improvement of slaughter characteristics such as a higher percentage of the carcass and a higher share of the breast (Du et al., 2023; Acharya et al., 2024).

However, many questions remain open, especially regarding the optimal combination of strains and concentrations of synbiotics, as well as their effectiveness in different production systems. The scientific literature is still not fully agreed on the quantitative effects of synbiotic supplements on broiler performance, which imposes the need for additional research under controlled conditions.

The aim of this work was to examine the effect of the addition of a synbiotic product, which contained several strains of beneficial bacteria and prebiotic components, applied through drinking water, on production and slaughter performance traits of Cobb 500 broilers. The obtained results can contribute to a better understanding of the practical value of synbiotics as a nutritional supplement in modern broiler production.

2. Materials and methods

2.1. Experimental design

The research was conducted at the Experimental Center of the Institute for Animal Husbandry in Zemun, under controlled conditions, on a total of 600 one-day-old broiler chickens of the Cobb 500 hybrid. The chickens were distributed according to a randomized block design, in order to eliminate the potential influence of microclimatic factors and divided into two groups: control (without the addition of synbiotics) and experimental (with the addition of a synbiotic preparation in drinking water). Each group had six replications, with 50 birds per box (12 boxes in total), and the size of each box was 5 m^2. The gender structure was evenly distributed among the replications to eliminate the effect of gender on the results. Animal handling and experimental procedures complied with national animal welfare regulations.

2.2. Food and water

During the entire fattening period, which lasted 42 days, broilers received three commercial complete mixtures according to their age. In the first phase, from the 1st to the 21st day of age, a starter mixture with a crude protein content of 21.6% was applied. In the second phase, from the 22nd to the 35th day, a grower mixture with 19.6% crude protein was used, and in the final phase, from the 36th to the 42nd day, a finisher mixture with 18.0% crude protein was given to broilers. All mixtures were formulated on the basis of maize and soybean meal, and prepared according to the nutritional requirements of the Cobb 500 hybrid. Food and water were available ad libitum. The experimental group received a synbiotic product diluted in drinking water at a concentration of 200 g/1000 L of water, continuously throughout the fattening period. The synbiotic product used in the experiment was commercially available on the Serbian market under the trade name SINBIOTIC. Its formulation included a mixture of probiotic strains (Enterococcus faecium, Lactobacillus casei, Lactobacillus plantarum, Pediococcus acidilactici) and prebiotic components (inulin, oligofructose, fructo-oligosaccharides, and maltodextrin).

2.3. Production parameters

The body weight of all chickens was measured individually on days 21, 35 and 42. Food consumption was monitored per box, as well as the number of deaths to calculate mortality. Based on these data, the following indicators were calculated: average daily feed consumption/intake (FI), average daily gain (ADG), feed conversion ratio (FCR) and mortality (%). Also, the European Production Efficiency Factor was calculated according to the formula: EPEF = (Liveweight, kg x Livability, % / Age of depletion, days x Feed Conversion Ratio, kg feed/kg gain) x 100.

2.4. *Slaughter parameters*

At the end of fattening (day 42), two chickens (male and female) whose body weights corresponded to the group average were selected from each box. A total of 24 broilers were slaughtered (12 per group). After slaughtering and cooling of carcasses (24 h at 4°C), the weight of the carcasses was measured and carcasses were cut into main parts (breasts, drumsticks, thighs, wings). At the same time, internal organs (liver, heart, stomach) and abdominal fat were measured and analyzed. All results are expressed as % of pre-slaughter body weight.

2.5. *Statistical data processing*

All data were processed using the STATISTICA 12 software package (StatSoft Inc., 2012). One-factor ANOVA was used for analysis, and significant differences between mean values were determined by the Tukey test. The experimental unit for production parameters was a box, while for slaughter traits it was an individual animal.

3. Results and Discussion

3.1. Production performance traits

The addition of synbiotic preparation to drinking water had a positive effect on most of the examined production parameters during different stages of fattening (Table 1). During the starter period (1–21 days), there were no statistically significant differences between treatments in terms of daily feed consumption/intake, daily gain, feed conversion ratio, mortality and EPEF. During the grower period (days 22–35), the synbiotic-supplemented group achieved a significantly higher average daily gain compared to the

control (106.85 g vs. 101.45 g), with better feed utilization, expressed by a lower conversion ratio (1.69 vs. 1.77). In the final, finisher phase (day 36–42), positive trends were also observed: average daily gain was significantly higher in the group treated with synbiotic (102.46 g vs. 93.49 g), while FCR was more favorable, although the difference did not reach the level of statistical significance (1.83 vs. 1.93). Observing the entire study period (1–42 days), the group receiving the synbiotic showed a statistically significantly higher average daily gain (73.44 g compared to 70.81 g in the control), as well as a more efficient feed conversion ratio (FCR 1.62 vs. 1.67). The European Production Efficiency Factor (EPEF) was also significantly higher in the treated group (453.33 vs. 420.82), which confirms the overall positive impact of the addition of synbiotics on the production performance of broilers.

Table 1.
Effect of synbiotic supplementation through drinking water on production performance of broilers during different stages of fattening

	Treatments (Groups)				SEM	*p* value
	Control		Synbiotic			
	Mean	SD	Mean	SD		
Starter period (1–21 d)						
FI, g/d	57.84	0.64	57.62	1.06	0.264	0.698
ADG, g/d	40.18	1.05	40.04	0.89	0.292	0.832
FCR, g/g	1.43	0.03	1.43	0.02	0.008	0.944
Mortality, %	1.00	0.91	0.67	1.49	0.373	1.000
Grower period (22–35 d)						
FI, g/d	176.41	8.71	180.44	2.92	2.049	0.356
ADG, g/d	101.45[b]	3.21	106.85[b]	2.16	1.214	**0.014**
FCR, g/g	1.77[b]	0.05	1.69[b]	0.05	0.019	**0.035**
Mortality, %	0.00	0.00	0.33	0.75	0.167	0.347
Finisher period (36–42 d)						
FI, g/d	177.14	15.77	186.62	4.57	3.804	0.233
ADG, g/d	93.49[b]	5.15	102.46[a]	2.53	1.923	**0.008**
FCR, g/g	1.93	0.22	1.83	0.09	0.053	0.381
Mortality, %	1.00	0.91	0.33	0.75	0.272	0.242
Whole period (1–42 d)						
FI, g/d	119.31	3.80	119.58	2.08	0.915	0.892
ADG, g/d	70.81[b]	1.93	73.44[a]	1.43	0.670	**0.040**
FCR, g/g	1.67[a]	0.03	1.62[b]	0.04	0.014	**0.049**
Mortality, %	2.00	1.39	1.33	1.39	0.430	0.471
EPEF	420.82[b]	15.04	453.33[a]	20.69	7.645	**0.022**

[a, b] In a row, the least squares means with a different superscript differ significantly ($p < 0.05$); SEM, Standard error of the means; SD, standard deviation; FI, feed intake; ADG, average daily gain; FCR, feed conversion rate; d, day

3.2. Slaughter performance traits

The results of the assessment of slaughter traits, shown in Table 2, indicate certain differences between the control and experimental groups. The most significant finding refers to the percentage of carcass in relation to body weight, which was statistically significantly higher in the group receiving the synbiotic (75.91% vs. 74.98%; p = 0.009). This result suggests that the use of synbiotics can contribute to a more efficient increase in muscle mass and a reduction in non-productive body components, which is extremely desirable from a production point of view. In addition, a tendency of increase in the proportion of breast muscle was observed in the treated group (30.29% compared to 28.48% in the control group), where the difference was not statistically significant (p = 0.085), but may have practical significance, bearing in mind that the breast muscle is the most commercial part of the broiler carcass. This trend may indicate a positive influence of synbiotics on the redistribution of body weight in favor of high-value muscle tissue, which is often associated with improving the functionality of the digestive tract and better utilization of nutrients. When it comes to the proportion of other carcass parts – such as drumsticks, thighs and wings – as well as internal organs (heart, liver, stomach) and abdominal fat, no statistically significant differences were observed between the control and symbiotic treatment groups. These results suggest that the main influence of synbiotics is expressed in segments that directly reflect muscle development, while the distribution of other components of the carcass and internal organs remains stable.

Table 2.
The influence of the addition of synbiotics on the slaughter performance traits of broilers at the end of fattening (day 42)

Parameter	Treatments (Groups)				SEM	*p* value
	Control		Synbiotic			
	Mean	SD	Mean	SD		
Body weight, g (BW)	3041.17	203.04	3168.67	396.26	88.762	0.499
Carcass weight, % BW	74.98[b]	0.52	75.91[a]	0.45	0.193	**0.009**
Breast, % BW	28.48	1.55	30.29	1.72	0.527	0.085
Drumsticks, % BW	11.39	0.65	11.11	0.77	0.200	0.512
Thigh, % BW	9.84	0.89	9.52	1.02	0.269	0.577
Abdominal fat, % BW	1.00	0.28	1.00	0.26	0.074	0.995
Heart, % BW	0.49	0.06	0.44	0.05	0.017	0.151
Liver, % BW	1.73	0.38	1.75	0.51	0.124	0.927
Gizzard, % BW	1.33	0.09	1.07	0.33	0.077	0.091

[a, b] In a row, the least squares means with a different superscript differ significantly ($p < 0.05$); SEM, Standard error of the means; SD, standard deviation

The obtained results clearly indicate a positive influence of the addition of the synbiotic product on the performance and, partly, slaughter traits of broiler chickens. Particularly significant effects were observed in terms of daily gain, feed conversion ratio and (EPEF), which confirms the functional value of this additive in modern poultry nutrition. The increase in daily gain in the symbiotic group, especially expressed in the grower and finisher phase, as well as during the entire fattening, is in accordance with numerous studies. These effects result in better nutrient absorption and higher energy utilization of feed, which probably directly contribute to better feed conversion ratio (lower FCR) and higher ADG in the symbiotic group. Increased daily gain and better feed conversion ratio can be attributed to improved digestion and absorption of nutrients, which is a consequence of stabilized intestinal microflora and reduced presence of pathogens in the digestive tract (Rahman et al., 2021). A study conducted by Awad et al. (2009) shows that synbiotics improve the morphology of the small intestine, increase the height of the villi and the depth of the crypts, thereby increasing the surface area for the absorption of nutrients. Similar findings were reported by Kostadinović et al. (2024), who demonstrated that replacing standard maize with quality protein maize in broiler diets improved feed conversion ratio. The results of Perić et al. (2010) indicate an improved absorptive capacity of the intestinal mucosa due to probiotic treatment, since larger and more developed villi allow a greater surface area for the absorption of nutrients. Improved intestinal morphology is often associated with better overall health of the digestive tract, reduction of pathogenic microflora and greater presence of beneficial bacteria, which additionally contributes to more efficient utilization of nutrients from food. The significance of these findings is also reflected in the fact that a healthier and more functional intestine directly affects growth, gain and feed conversion in broilers. The benefits of the addition of synbiotics on production performance are also confirmed by Kridtayopas et al. (2019), who point out that synbiotic supplementation is one of the more effective strategies for optimizing productivity under stress conditions. Nisar et al. (2021) show in their research that dietary supplementation with symbiotics significantly improves the digestibility of nutrients. This improved digestive efficiency is directly reflected in improved feed conversion. The improvement of production results is also reported by Mucci (2017), where broilers receiving synbiotic supplements had improved growth and feed consumption in the first 10 days of growing compared to the control group.

When it comes to slaughter performance traits, there is a particularly significant increase in the percentage of carcass in relation to body weight in the treatment group. Although statistically insignificant, the higher percentage of breast in the symbiotic group may have economic importance, given that it is the most commercially valuable carcass part. These findings are also supported by Cheng et al. (2017), who show that synbiotic supplements can influence the redistribution of body weight towards greater muscle development. This is confirmed by the research of Raksasiri et al. (2018), indicating that synbiotics can affect the reduction of visceral fat and the increase of muscle mass, especially in the breast area. Decreasing pathogenic flora and increasing beneficial microbiota in the gut can contribute to the reduction of inflammatory processes, allowing energy to be redirected towards muscle growth rather than immune responses (Oakley et al., 2014). However, the positive impact of synbiotics on slaughter traits has not always been recorded. For example, Sarangi et al. (2016) in their research find no significant differences in performance between the control and treatment groups, despite the use of probiotics, prebiotics and synbiotics. This indicates that the effect of synbiotics may depend on several factors, including the type and dosage of the additive, the duration of treatment, the health status of the poultry and the basic composition of the diet.

Despite the positive results, it should be noted that the effects of synbiotics can vary significantly depending on their formulation (type and number of probiotic strains, type of prebiotics), housing conditions and genetic potential of broilers. Therefore, it is important to further optimize the dosage and selection of components of synbiotic products through additional research in different production conditions.

4. Conclusions

The results of this study demonstrate that supplementation with a synbiotic product via drinking water can significantly improve production performance in broiler chickens. Broilers in the treatment group showed higher average daily gain, better feed conversion, and improved EPEF compared to the control group. Additionally, a significantly higher carcass yield and a noticeable trend toward an increased proportion of breast muscle were observed.

These findings indicate that synbiotic supplements represent an effective alternative for improving the growth and production efficiency of broilers; they can contribute to the improvement of carcass quality without negative effects on animal health.

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