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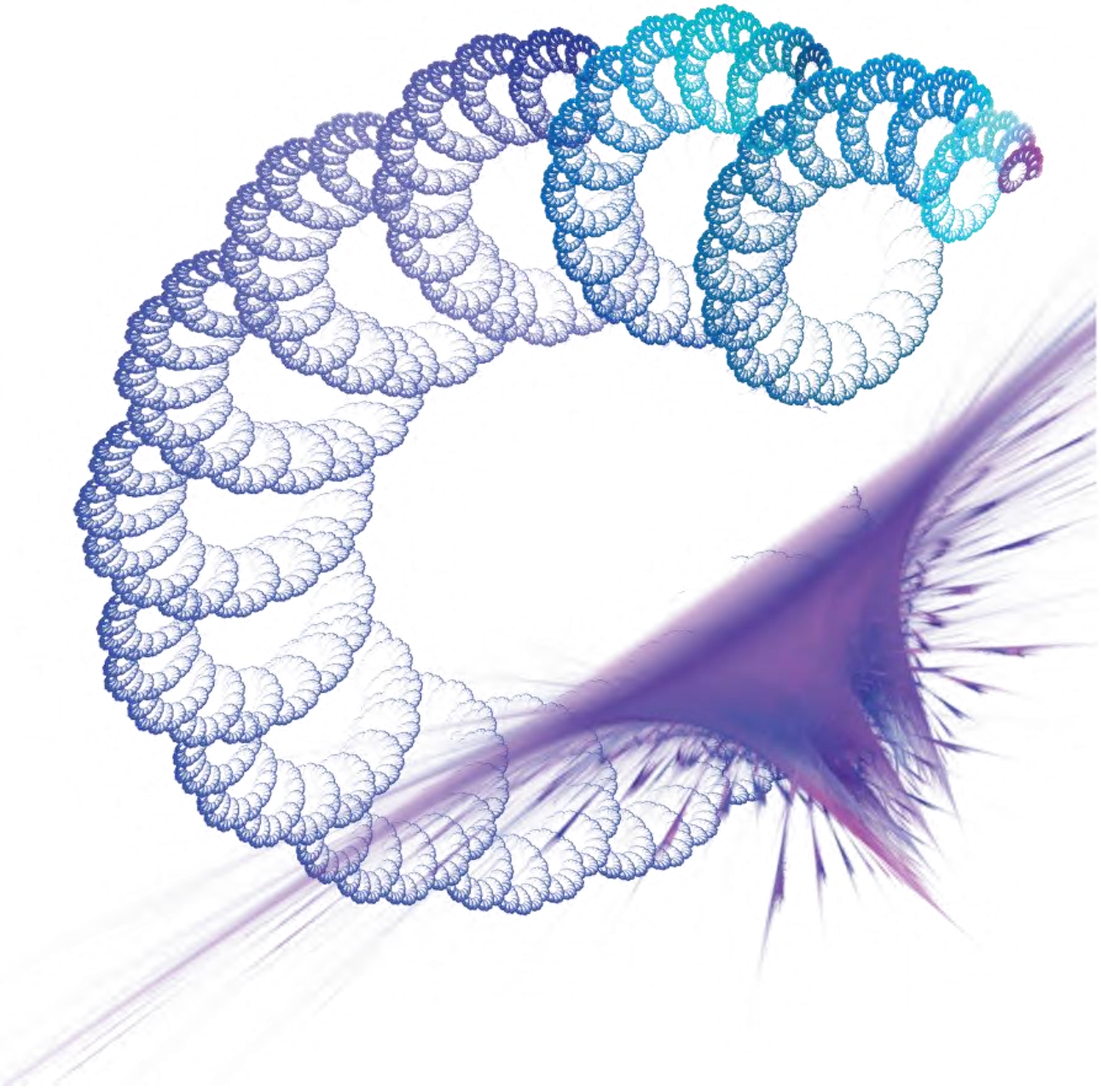
Regulatory Mechanisms in Biosystems



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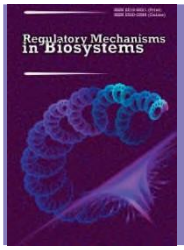

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Aims and scope. *Regulatory Mechanisms in Biosystems* publishes peer-reviewed original research and review articles across all aspects of regulatory mechanisms in biological systems from the molecular level of organisation to the level of the organism. This journal mostly focuses on physiological mechanisms of regulation of metabolic processes, biochemical and physiological features of any species including human beings. This journal covers a wide range of regulatory mechanisms in biological systems that are associated both with natural processes and those transformed under the influence of chemicals and drugs, and any other man-made factors. We will publish papers concerned solely with clinical case studies and clinical trials if such articles address important questions in regulatory mechanisms in biosystems. *Regulatory Mechanisms in Biosystems* focuses on good-quality research, reporting scientifically sound observations and valid conclusions, which bring new and important information to the attention of the wider international scientific community. The journal publishes contributions in the following basic areas: biochemistry, bioinformatics, biophysics, cell biology, endocrinology, genetics, immunology, microbiology, molecular biology, physiology, neuroscience, pharmacology, toxicology.

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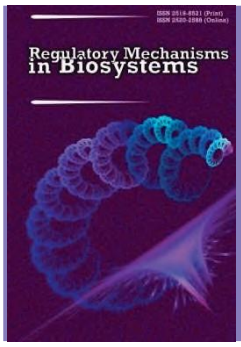

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Efficiency of a food supplement containing *Saccharomyces cerevisiae* culture in the diet of broiler chickens

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Currently, high productivity parameters in poultry farming are achievable only by maximum fulfillment of the poultry's biological needs, because only healthy and highly productive birds can be the basis of the sphere's profitability. All this is closely associated with the usage of feed additives of natural origin and effective methods of poultry farming, which provide high productivity and natural resistance of a bird's body. In the experiment, we examined the effects of a probiotic feed additive on the productivity and slaughter parameters of the broiler chickens. Intake of the feed supplement by the experimental-group broiler chickens increased their live weight by 5% at the age of 28 days, 12% at the age of 35 days, and by 14% at the age of 42 days, compared with the control group. Using the tested probiotic feed supplement in the diet increased the mean daily (by 15.9%) and absolute increments (by 14.4% compared with the control group). Intake of the probiotic feed supplement by broiler chickens of the experimental group increased their pre-slaughter live weight by 14.2%, weight of non-processed carcasses by 15.5%, semi-processed carcass by 15.7% and processed carcass by 15.3%, compared with the parameters of the control group. In broilers of the experimental group, there were increases in the general weight of muscles (10.3%), namely the breast muscles (11.8%), muscles of thighs and lower legs (9.8%), and weight of the gizzard (by 6.5%), compared with the control group. Intake of the probiotic supplement by the experimental-group broiler chickens resulted in increases in width of the proventriculus (28.5%), length of the gizzard (16.3%) and width of the gizzard (29.7%), compared with the control group of animals. The probiotic feed supplement increased the length of the duodenum (by 7.6%) and the jejunum (by 4.5%) in the experimental-group broiler chickens, against the control. Therefore, feed supplements based on cheap culture *Saccharomyces cerevisiae* are promising, because they are able to enhance the effectiveness of poultry farming at relatively small costs.

Keywords: poultry farming; probiotics; productivity; live weight; slaughter parameters; digestive organs; feed conversion.

Introduction

In the conditions of growing competition on the global market, many countries have to search for new ways of enhancing the economic efficiency of the production and improvement of meat quality. Meat poultry farming provides the population with dietary high-calorie products that are better than most other food products in terms of nutrition value. Therefore, the products for the population need to be ecologically safe. Restriction or prohibition of using some types of antibiotics in poultry nutrition improves the meat safety, but decreases the rates of weight accumulation in broilers. This in turn has encouraged researchers and practitioners to seek natural-origin supplements containing biologically active compounds that would boost productivity, strengthen immunity, and improve digestion (Nosrati et al., 2017; Yaremchuk et al., 2022).

The main goal of modern studies is optimizing the use of feed supplements of natural origin in animal farming (Chudak et al., 2020; Razanova et al., 2022). Over recent years, research and use of biologically active supplements have been quite active in poultry farming. They are promising because of their bioavailability, absence of unsatisfactory side effects and because of a broad range of biological effects on the body (Podolian, 2017; Sumanu et al., 2023).

According to some authors (Souza et al., 2018; Ramlucken et al., 2020), probiotics optimize the intestinal bioceoenosis. Intake of probiotic supplements promotes the formation of beneficial gut microflora in broilers, characterized by high content of lactic-acid bacteria. Probiotics are considered biologically active compounds of natural origin based on beneficial microorganisms belonging to the normal flora of the organism. When they are consumed, probiotic microorganisms inhabit the intestine, "extruding" pathogen organisms from the intestinal epithelium and thus strengthen the immunity (Park & Kim, 2014; Bai et al., 2017).

Therefore, the objective of our study was to assess the effect of a probiotic feed supplement on the productivity and slaughter parameters of broiler chickens in industrial conditions.

Materials and methods

The protocol we followed and the procedures by we performed this study ethically corresponded to Directive 2010/63/EU of the European Parliament and the Council of Protection of Animals, and also Law of Ukraine on Protection of Animals from Abuse. The program of the experiment was approved by the Commission of the Faculty of Technology of Production and Processing Products of Animal Husbandry and Veterinary Medicine of the Vinnytsia National Agrarian University.

We studied the influence of the EnzActive probiotic feed supplement on the productivity and slaughter parameters of the broiler chickens in the vivarium of the Vinnytsia National Agrarian University. The experiment was carried out according to the study methods of Ibatullin et al. (2017). To analyze the productivity of broiler chickens fed with the studied feed supplement, we selected 40 broiler chickens. They were formed into two groups of broilers, 20 in each. The experiment lasted for 42 days. Zoohy-

gienic growing conditions were the same in all groups. All the chickens were given a balanced full-diet mixed feed according to the norms for growing age periods. The control group of poultry consumed the main diet, and the experimental was fed with the full-diet mixed feed supplemented with EnzActivet in the dose of 100 g/t of feed.

The EnzActive probiotic feed supplement contains *Saccharomyces cerevisiae* culture, a yeast strain specially selected because of its action in the digestive system of animals, in the amount of 1.3×10^{10} CFU/g.

Growth rates of the broilers were measured every week during growth. We monitored the live weight of the broiler chickens. The young were weighed individually on the Aurora AU 309 scales with up to 1 g accuracy. Moreover, we estimated feed consumption and feed conversion per 1 kg of live-weight increment. Throughout the study, we monitored live-weight gains in the poultry. According to the results of changes in live weight of the broilers, we determined the growth intensity according to the absolute and mean-daily increments.

The broiler chickens (in both control and experimental groups) were slaughtered on the 42nd day, 5 individuals from each. Avascularization of the poultry was carried out by cutting the neck vessels. The carcasses were then treated with hot water in +51…+57 °C temperature for 2 min. To identify morphological composition of carcasses of the broiler chickens, we determined body weight prior to slaughter, weight of non-processed, semi-processed (i.e. those with removed intestines and cloaca, filled crop, oviduct and ovary (in female specimens)), processed carcasses (the internal organs and abdominal-cavity fat and esophagus of which were removed, without head, legs and wing metacarpals), slaughter yield, and weight of the muscles. During the control slaughter, we weighed the internal organs and measured their linear measurements.

We estimated the mean arithmetic values and standard deviation (SD). The results were analyzed using ANOVA. Differences between the groups were considered significant at $P < 0.05$ (accounting for Bonferroni's correction).

Results

Intake of the feed supplement by broiler chickens of the experimental group increased the live weight by 5% ($P < 0.01$) at the age of 28 days, by 12% ($P < 0.001$) at 35 days, and by 14% ($P < 0.001$) at 42 days, compared with their control peers (Table 1).

Table 1
Dynamics of live weight (g) of broiler chickens consuming the feed supplement containing *Saccharomyces cerevisiae* culture ($x \pm SD$, $n = 20$)

Age, days	Control group	Experimental group
1	50.2±3.4	49.5±2.8
7	133.4±6.3	135.6±5.4
14	485.6±8.4	500.8±9.3
21	926.5±12.2	958.6±11.2
28	1486.8±15.3	1562.8±14.6**
35	1875.5±16.4	2102.6±15.6***
42	2315.0±18.6	2640.7±19.8***

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$ between the control and experimental groups for a certain period of the experiment.

The poultry that had consumed the examined feed supplement had higher (by 15.9%, $P < 0.05$) mean daily increment than the control animals. It has to be noted that broilers of the experimental groups had the absolute increment of 2,591.2 g, which was 14.4% ($P < 0.01$) higher than the control (Table 2).

Table 2
Increments (g) in broiler chickens consuming the probiotic feed supplement ($x \pm SD$, $n = 20$)

Group	Mean daily increment	Absolute increment
Control	53.9±1.8	2,264.8±15.2
Experimental	61.7±2.1*	2,591.2±16.5***

Note: see Table 1.

The broilers that were consuming the probiotic feed supplement ate more food during the study (by 4.3%), though feed conversion per 1 kg of increment was 4.9% lower than in the control (Table 3).

Table 3
Feed conversion (kg) of broilers fed with the probiotic feed supplement

Group	For the period of experiment	Per individual	Feed conversion per 1 kg of increment
Control	83.6	4.40	1.82
Experimental	87.2	4.45	1.73

Our experiment revealed that the feed supplement increased the slaughter parameters of the experimental-group broiler chickens (Table 4).

Table 4
Slaughter parameters of broiler chickens consuming the probiotic feed supplement containing *Saccharomyces cerevisiae* culture ($x \pm SD$, $n = 5$)

Parameter	Control group	Experimental group
Pre-slaughter weight, g	2,302.4±22.3	2,628.5±25.2****
Non-processed carcass, g	2,153.5±23.9	2,487.1±22.5***
Semi-processed carcass, g	1,982.6±15.8	2,294.2±19.3***
Processed carcass, g	1,608.0±20.4	1,854.5±21.4***
Slaughter yield, %		
– non-processed carcass	93.5±0.4	94.6±0.3
– semi-processed carcass	86.1±0.3	87.2±0.5
– processed carcass	69.8±0.5	70.5±0.4
Weight of muscles, g	1,026.3±19.5	1,131.6±20.2**
Weight of breast muscles, g	402.8±13.4	450.6±12.1*
Weight of thighs and lower legs, g	428.5±12.3	470.8±11.8*
Weight of torso, wings, neck, g	195.0±13.2	210.2±10.5

Note: * – $P < 0.05$, ** – $P < 0.01$, *** – $P < 0.001$ between the control and experimental groups.

Intake of the probiotic feed supplement by chickens of the experimental group increased the pre-slaughter live weight by 14.2% ($P < 0.001$), weight of non-processed carcass by 15.5% ($P < 0.001$), semi-processed carcass by 15.7% ($P < 0.001$) and processed carcass by 15.3% ($P < 0.01$), compared with the control group of animals. In broilers of the experimental group, there was increase in the general weight of the muscles (10.3%, $P < 0.01$), namely the breast muscles (11.8%, $P < 0.05$), muscles of thighs and lower legs (9.8%, $P < 0.05$), compared with the control group.

During slaughter, we examined weight of the main internal organs of the broiler chickens (Table 5): in the experimental-group broilers, weight of the gizzard was 6.5% ($P < 0.05$) higher than in the control group. According to the rest of the parameters, we observed a tendency towards increase in weight of the internal organs, though no significant difference was found.

Table 5
Weight of the internal organs of broilers (g) consuming the probiotic feed supplement ($x \pm SD$, $n = 5$)

Parameter	Control group	Experimental group
Heart	12.8±0.7	13.5±0.4
Gizzard	58.6±1.3	62.4±0.7*
Liver	60.5±1.3	61.2±1.4
Lungs	13.8±0.9	14.4±0.3
Kidneys	12.1±0.6	13.2±0.3

High intensity of metabolic processes in the birds was caused by high activity of digestion. In the digestive organs of the broilers, hydrolysis of nutrients included in the diet was closely associated with the physical condition of the animal and its productivity. During the control slaughter, we measured the main linear measurements of the broiler chickens (Table 6).

The probiotic supplement increased the width of the proventriculus (28.5%, $P < 0.05$), length of the gizzard (16.3%, $P < 0.05$) and width of the gizzard (29.7%, $P < 0.05$). Intake of the supplement increased the length of the duodenum (7.6%, $P < 0.05$) and the jejunum (4.5%, $P < 0.01$) in the broilers, compared with the control. This may indicate intensification of digestion and absorption of the feed nutrients.

Discussion

In animal farming, natural-origin biologically active supplements that have no negative effect on the body are becoming increasingly popular. This allows developing safe food products (Chudak et al., 2019). Some

authors consider probiotics as preparations of microbial origin which exert properties through regulation of the intestinal microflora (Ogbuagu et al., 2018; Goktas et al., 2022). The main mechanism of action of probiotics lies in inhabitation of the gastrointernal tract by strains that are beneficial to animals, and extrude the conditionally pathogenic microflora from the intestinal biocoenosis (Poberezhets et al., 2021). Some species of fungi of the *Saccharomyces* genus exert biotic action and stimulate the digestion activity (Lee & Lee, 2022). We studied the effect of the probiotic supplement made of a *S. cerevisiae* culture on the productivity and slaughter parameters of the broiler chickens. The results revealed that intake of the probiotic feed supplement containing *S. cerevisiae* by the broiler chickens of the experimental group had positive effects on the productivity, increasing the live weight, mean daily increment, and absolute increment. Similar experiments were performed by other researchers, who reported positive effect of a probiotic supplement on live weight, mean daily increment, feed conversion, and yield of processed carcass (Harrington et al., 2016; Zhang et al., 2021; Sumanu et al., 2023).

Table 6

Linear measurements of the digestive organs (cm) after consuming the probiotic supplement containing *Saccharomyces cerevisiae* culture (x ± SD, n = 5)

Parameter	Control group	Experimental group
Length of esophagus	11.4±0.4	12.6±0.8
Length of proventriculus	4.2±0.3	4.5±0.5
Width of proventriculus	2.1±0.1	2.7±0.2*
Length of gizzard	4.9±0.2	5.7±0.3*
Width of gizzard	3.7±0.4	4.8±0.2*
Small intestine		
Length of duodenum	34.2±0.6	36.8±0.8*
Length of jejunum	107.2±0.8	112.1±0.5**
Length of ileum	29.3±1.1	31.3±0.8
Large intestine		
Length of right cecum	22.3±0.9	23.4±0.6
Length of left cecum	20.5±1.2	22.6±1.3
Length of rectum	9.3±1.3	10.1±1.1

Chudak et al. (2021) found that using probiotic supplements in feeding laying hens promoted increase in live weight, increments, egg-laying productivity, and 13.6% decrease in feed conversion per 10 eggs in the experimental group, compared with the control. Such results are explained by positive influence on the gut microflora, which intensifies digestion and absorption of nutrients from fodders. Boroojeni et al. (2018) and Ramlucken et al. (2020), when feeding probiotic supplements to the broiler chickens, came to the conclusion that they improved not only the productivity but also metabolism of nutrients. According to Rehman et al. (2020), a probiotic based on bacterial strain of the *Bacillus* genus increased the productivity of broilers and improved the gut microflora. Favourable effects of probiotics are explained by their competition with pathogenic bacteria for nutrients and areas for attachment and formation of such counteragents as lactoferrin, lysozyme, hydrogen peroxide or other organic acids. According to Sen et al. (2012), a *B. subtilis*-containing probiotic, consumed in different amounts, increased increment in live weight and improved the fodder consumption and conversion. Improvement in the productivity and characteristics of carcasses when using probiotics can occur because of increased consumption and better metabolism of the diet (Shim et al., 2010). Other researchers have not confirmed the positive effect of probiotic supplements on the productivity (Shargh et al., 2012; Nosrati et al., 2017) and increase in the slaughter parameters (Souza et al., 2011; Domingues et al., 2014). Therefore, the influence of probiotics on productivity and quality of products of animal farming should be studied in more detail.

Our study demonstrated that intake of the probiotic by broiler chickens of the experimental group increased the pre-slaughter live weight, weight of non-processed carcass, semi-processed carcass, and processed carcass, compared with the control group. Subject to the probiotic feed supplement, broiler chickens of the experimental group were observed to have increase in the general weight of muscles (including breast, thigh, and lower-leg). Results of many studies have shown positive effect of probiotics on the productivity and slaughter parameters of broiler chickens (Park & Kim, 2014; Cramer et al., 2018). Similar results were obtained by other authors, who have confirmed that intake of a probiotic by the broiler chickens increased the pre-slaughter weight by 15.5%, weight of non-processed carcass by 15.6%, semi-processed weight by 16.8%, processed carcass by 7.9%, proventriculus by 35.0%, breast and thigh muscles by 17.7% and 13.0%, respectively, compared with the control (Podolian, 2016; Souza et al., 2018).

At the same time, during the experiment, we determined the effect of the probiotic on weight and linear measurements of the internal organs. Usage of the probiotic supplement in the diet of broiler chickens of the experimental group increased weight of their gizzard, width of proventriculus and gizzard, length of gizzard, duodenum, and jejunum. The results of our studies are consistent with the experiments of Yun et al. (2017), who studied effects of probiotic supplements on the poultry organism and determined that their positive action stretches beyond the productivity and metabolism of nutrients, also enhancing relative weight gain of the digestive organs and improving the gut microflora. According to Bansal et al. (2011), this may be associated with the inhibiting effect probiotics have on pathogenic microflora, which improves the gut health. Thus, using probiotics in feeding poultry is positive for the productivity, slaughter parameters, and feed conversion as a result of extrusion of pathogenic gut microflora and recovery of the normal biocoenosis, which increase digestibility and metabolism of fodder nutrients.

Conclusions

Intake of the probiotic feed supplement by broiler chickens of the experimental group increased their live weight by 14.0% ($P < 0.001$), mean daily increment by 15.9% ($P < 0.05$), and absolute increment by 14.4% ($P < 0.01$), compared with their control peers. Intake of the probiotic by broiler chickens of the experimental group increased the pre-slaughter weight by 14.2% ($P < 0.001$), weight of non-processed carcass by 15.5% ($P < 0.001$), semi-processed carcass by 15.7% ($P < 0.001$), processed carcass by 15.3% ($P < 0.01$), and increased the general weight of the muscles by 10.3% ($P < 0.01$), particularly the breast muscles by 11.8% ($P < 0.05$), muscles of thighs and lower legs by 9.8% ($P < 0.05$), and weight of the gizzard by 6.5% ($P < 0.05$), compared with the control group. Consumption of the probiotic supplement by broiler chickens of the experimental group caused 28.5% ($P < 0.05$) increase in width of the proventriculus, 16.3% ($P < 0.05$) in length and 29.7% ($P < 0.05$) in width of the gizzard, against the control. Use of the probiotic in the diet of experimental-group broilers increased length of the duodenum (by 7.6%, $P < 0.05$) and the jejunum (by 4.5%, $P < 0.01$), compared with the control group.

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The authors declare no conflict of interests.

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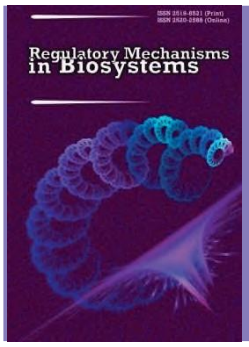

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