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The Study of the Effectiveness of the Use of a New Feed Supplement Albit-Bio in the Diet of Quail

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Abstract | This article presents the results of a study of the effect of a feed additive "Albit-BIO", on the body quail meat productivity. This feed additive made from autolysate of the biomass of Cephaliophora Tropica fungus, saturated with selenium, iodine, iron, calcium, magnesium, zinc, manganese, copper, cobalt, and boron. As a result of the studies, found that the addition in the diet of quail feed additive helps increase poultry safety by 3.5 %, live growth by 6.6 % while reducing feed consumption for growth by 1.5 %. Revealed that the use of autolysate from the fungus in the diet of birds helps increase protein, mineral, and fat metabolism, and increases the quail's immune status. The feed additive had a positive effect on the digestibility of the feed components, stimulated the growth of beneficial microflora, and inhibition of growing the opportunistic microorganisms. The use of additives helps improve the chemical composition of the bird's muscles by reducing the fat content and increasing protein, as well as increasing the dietary properties of meat products and its biological value. In general, the use of the feed additive Albit-BIO as part of the quail diet increases the meat productivity of poultry and improves the quality of the obtained quail products.

Keywords | Feed additive, Meat productivity, Hematological indicators, Biochemical indicators, Meat quality

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INTRODUCTION

Poultry farming is one of the leading branches of agriculture. An essential factor determining the industry's industrialization is its early maturity and quick return on investment (Antipov et al., 2011).

One of the directions in poultry farming is a quailing investment (Antipov et al., 2011; Ahmad et al., 2018). Currently, the industrial breeding of quail is actively engaged in most countries of the world. Great importance is attached to scientific research in this industry. Research institutes established in China and India, and research centers in Japan investment (Alagawany et al., 2019). Domestic quails were first brought to Russia in 1964 from Yugoslavia investment (Karapetyan, 2014). One of the quail characteristics is the temperature of their body, which is why they have a more intense metabolism and are thus an attractive biological model for conducting research work investment (Luneva et al., 2019; Markovic et al., 2018).

An insufficient amount of macro- and microelements in the body of farm animals, including poultry, harms the body's vital functions, which affects overall health investment (Lysenko et al., 2019). Trace elements included in the structure of coenzymes of the main enzymes that regulate the immune response of a microorganism. A significant role for the body is played by selenium, which in turn, is a deficiency in feed mixtures. Therefore, the weakness of this microelement in the body dramatically affects the health of animals, including birds, which primarily causes diseases of the gastrointestinal tract investment (Gushchin and Kroik, 2013; Dal Bosco et al., 2016).

The development of biotechnology has led to the appearance of feed products and biologically active additives with new properties. In this regard, the development and use in the diets of farm animals and poultry feed additives based on a complex of trace elements is a promising direction investment (Temiraev et al., 2017; Okuskhanova et al., 2019).

One of such feed additives is LLC "Albit", based on the autolysate of the biomass of mushroom culture, saturated with microelements under the trade name "Albit-BIO" (TU 9296-008-73057769-2011). This additive designed to balance feed by essential microelements to increase quickly and reliable maintenance at a high level of productivity of animals and birds (Zibrov and Ratoshny, 2011; Skvortsova et al., 2018, 2019). The work aims to study the effect of the mushroom autolysate "Albit-BIO" on the body of quail and the quality of meat production of quail.

MATERIALS AND METHODS

The experiments conducted in the vivarium of the Department of Biotechnology, Biochemistry, and Biophysics, Federal State Budget Educational Institution of Higher Education Kuban GAU on quails of the Texas breed (white meat quail). They bred by the staff of the breeding and genetic center of the All-Russian Institute of Poultry and LLC Genofond.

The object of research was the feed additive "Albit-BIO," which is an autolysate of the biomass of the fungus Cephaliophora Tropica, saturated with selenium, iodine, iron, calcium, magnesium, zinc, manganese, copper, cobalt, and boron.

By the method of analog groups, formed two groups of quail, 200 animals each: control, which received a standard diet, according to age periods and experimental, and the quail drinking system, a feed additive was added daily, according to the manufacturer's recommendations. The experiment lasted for 56 days.

In the laboratory, quails were grown in semi-industrial multi-story metal cages. Each tier of the cage (5-story) divided into two sections, each of which housed 20 goals. Water supply - automatic through nipple drinkers. Compound feeds, according to age periods, were distributed manually in a bunker hanging feeder. The biological product was given to the bird daily by evaporation through a general drinking system or vacuum drinkers with water.

Every day, the bird's clinical and physiological state monitored by examining the livestock while paying attention to behavior, mobility, feather cover, feed intake, and water consumption. In all, the studied groups calculated the percentage of bird safety for the entire experiment period. Weekly, the dynamics of the live weight of birds, was studied by individual weighing. The difference in the initial and final masses calculated the gain of the bird for the entire experiment (Koshchaev et al., 2018). Daily accounting for the consumption of feed by the bird. Feed conversion calculated as the ratio of feed consumed to 1 kg of growth over the entire study period.

To study the indicators of meat productivity after applying a feed additive in the diet of birds at the end of the study, they were slaughtered and anatomically cut.

To study the digestibility of the components of the compound feed by the bird. A balance experiment was carried out a week before the end of the studies. The morphological status of the blood of the bird was studied. The number of cells (red blood cells, white blood cells, and platelets) in whole blood counted in a chamber with a Goryaev grid. The erythrocyte hemoglobin content was measured using a HemoCue Hb analyzer. Serum biochemical parameters (total protein, albumin, globulins, cholesterol, phosphorus, calcium, ALT, and AST activity) studied on a Stat Fax 4500 semi-automatic benchtop analyzer. By in vitro, analyzed bactericidal and lysozyme activity of blood serum (BABS and LABC).

After using the biological product were analyzing the muscle tissue chemical composition of birds. We studied the moisture content according to GOST 9793-74, fat-GOST 23042-78, and protein GOST 25011-81. The dietary property of poultry meat determined by the ratio of fat to protein (meat quality index). The amino acid rate of the muscles of experimental birds was studied by capillary electrophoresis on a device "Drops-105 M", using preliminary hydrolysis of meat protein in an acidic way.

After the slaughter of quails, resection of the intestine performed to study the microbial background. The intestinal contents resuspended in physiological saline and identified microflora according to the guidelines.

The data obtained in the experiments were subjected to biometric processing using Microsoft® software. The reliability criterion determined according to the Student's table. The difference was considered significant at $P < 0.05$.

RESULTS AND DISCUSSION

Quail' growth and development

The experiment used quail with signs of a clinically healthy bird. Throughout the investigation, some zootechnical indicators have taken into account, the results of which are in Table 1.

Table 1: Zootechnical indicators of quail (n = 200).

Index	Group	
	Control	Experienced
Quail preservation, %	95,5	99,0
The dynamics of live weight, g.		
daily	10,65±0,11	10,58±0,10
7 days	80,43±0,87	84,43±0,86
14 days	134,56±2,01	139,48±2,13
21 days	193,56±2,12	202,84±1,96
28 days	238,45±1,96	249,76±1,94*
35 days	286,56±2,02	298,32±2,03*
42 days	308,75±2,13	323,54±2,18*
49 days	319,86±2,28	334,84±2,19*
56 days	327,85±2,32	348,56±2,35*
Growth of live weight during the growing period (0–56 days)		
One head on average, g	317,20	337,98
Feed consumption during the growing period (0–56 days)		
1st head, g	1056,47	1107,65
Conversion rate, kg	3,33	3,28

* the difference with the control is significant (P < 0,05).

When studying the safety of quail for the growing period (56 days), it has found that the highest survival of birds has recorded in the experimental group, which was 99.0 %. The lowest safety (95.5 %) has observed in the control group of quail.

When studying the live weight of quail, it has found that already in the first week of life, when weighed, a slight tendency to increase this indicator in the experimental group was revealed. So, in the experimental group on the 7th day of weighing, the index of the quail's live weight was slightly higher than in the control group by 5.0 %. Up to 21 days has observed a similar picture. However, from the 28th day to the end of the experiment, it has revealed a statistically significant difference in the studied parameter into an experimental group compared by the control group of birds. On the 28th day of weighing quails, it has found that the weight of birds in the experimental group was significantly higher than in the control group by 4.7 % at P <0.05. On the 35th day, the live weight of quail in the experimental group was higher than in the control group by 4.1 % (P <0.05). Similar statistically significant (P <0.05) indicators in the experimental group by the control group were identifying on the 42nd and 49th day of weighing quails. On the 56th day, significant differences recorded in the experimental group compared with the control group and higher by 6.3 % (P <0.05).

The calculation of the quail growth in all groups showed that in the experimental group, the studied indicator exceeds the control by 6.6 %.

One of the leading zootechnical indicators of the effectiveness of using additives in the diet of birds is the indicator of feed consumption per 1 kg of weight gain (conversion). Analysis of this value showed that in the control group, 1 kg of growth requires 3.33 kg of feed, while in the experimental group, 3.28 kg is needed, which is 1.5 % lower than in the control group.

Thus, the quail, which received the Albit-BIO feed additive in their diet, had the best zootechnical indices compared with poultry without additional biological preparations.

Morphological and biochemical parameters of the blood

Analysis of these blood components allows you to identify the functional state of internal organs and detect the development of pathological and inflammatory phenomena in the body. In this regard, in the middle (28th day) and at the end (56th day) of the experiment, the birds were slaughtered. Blood has been taking to study the effect of the feed additive on the bird's body through its morphological and biochemical parameters. The analysis data of whole blood and its serum are in Tables 2 and 3.

Table 2: Morphological analysis of the blood of quail (n = 10).

Index	Group	
	Control	Experienced
28th day		
Hemoglobin, g / l	128,56±3,33	132,54±3,53
White blood cells, 10^9 / l	23,65±0,64	22,43±0,52
Platelets, 10^9 / L	123,32±3,56	127,37±3,68
Erythrocytes, 10^{12} / l	3,65±0,10	3,75±0,10
56th day		
Hemoglobin, g / l	3,42±0,08	3,52±0,11
White blood cells, 10^9 / l	121,56±3,86	126,83±3,95
Platelets, 10^9 / L	26,34±0,54	24,73±0,49
Erythrocytes, 10^{12} / l	127,54±3,94	131,76±4,01

Studying the morphological composition of individual blood cells, we found a positive effect of the use of feed additives in the quail diet. So, on the 28th day, the number of red blood cells in the blood of birds of the experimental group was slightly higher than in control by 2.7 %. A similar dynamics observed on the 56th day of the study of this indicator, which was 2.9 % higher. Also, a slight definite increase found in platelets in the experimental group. So, on the 56th day, the platelet count compared with the control group was higher in the experimental group by 4.3 %. The leukocyte count on the 28th and 56th day of analysis in all groups was almost the same. Positive dynamics recorded in the amount of hemoglobin in the blood of quail. So, on the 28th day of studying the whole

blood of birds into an experimental group, the hemoglobin level was physiologically higher than from birds of the control group by 3.1 %. The 56th day of research of this indicator has been revealing a similar picture.

In general, a statistically significant difference in the context of the studied groups has not revealed by the analyzed blood parameters. At the same time, the introduction of a bio preparation into the diet of the experimental quail group contributed to an insignificant physiologically average increase in red blood cells, platelets, and hemoglobin, which ensured growth in the birds' metabolic processes.

The analysis of blood serum of quail also demonstrated a positive effect on the body of birds of the applied feed additive (Table 3).

Table 3: Biochemical analysis of blood serum of quail (n = 10).

Index	Group	
	Control	Experienced
28th day		
Total protein, g / l	33,23±0,87	36,76±1,02
Albumin, g / l	14,56±0,32	16,32±0,42
Globulins, g / l	18,67±0,54	20,44±0,51
A / G ratio	0,77±0,01	0,80±0,01
Cholesterol, mmol / l	3,52±0,08	3,38±0,09
AST, units / l	354,24±7,54	347,67±7,86
ALT, units / l	25,67±1,01	24,87±1,05
Phosphorus, mM / L	2,17±0,04	2,24±0,05
Calcium, mmol / l	1,85±0,05	2,00±0,04
BABS,%	40,7±1,56	47,4±1,43
LABC,%	31,2±1,05	35,1±1,09
56th day		
Total protein, g / l	34,56±0,91	36,87±0,94
Albumin, g / l	15,11±0,21	16,78±0,36
Globulins, g / l	19,45±0,52	20,09±0,51
A / G ratio	0,77±0,01	0,84±0,01*
Cholesterol, mmol / l	3,87±0,05	3,65±0,06*
AST, units / l	335,36±6,78	328,87±6,89
ALT, units / l	24,61±1,02	23,96±1,01
Phosphorus, mM / L	2,19±0,01	2,29±0,01*
Calcium, mmol / l	1,92±0,01	2,07±0,01*
BABS,%	43,1±0,86	52,3±1,02*
LABC,%	33,5±0,53	39,5±0,56*

* Significant difference with control (P < 0,05).

The studies of quail blood serum at 28 days of age showed a positive dynamics of the studied parameters in the experimental group. The protein amount in the blood of birds from the experimental group was higher than in the control group by 10.6 %. The number of protein fractions in the blood serum of quail of the experimental group was also higher than in the control group: albumin by 12.1 %, and globulin - 9.5 %. The albumin-globulin coefficient in the birds' blood from the experimental group exceeded the value of this indicator in the control group by 3.9 %. Similar positive data has obtained in the study of other blood serum indices on the 28th day of studies without showing a statistically significant difference. However, on the 56th day of the experiment, when analyzing quail blood serum, a statistically significant difference was found for individual studied parameters. So, in the experimental group of birds in the blood serum, the protein ratio (A / G) was significantly higher than in the control group by 9.1 % (P <0.05). The level of cholesterol in the blood of quail of the experimental group was lower than in control by 5.7 % with a statistically significant difference (P <0.05). There was a positive trend in the study of serum enzymes of quail from the experimental group. So, the AST content in the blood of quail of the experimental group was slightly lower than in the control group by 1.5 %. The serum ALT enzyme level in the experimental group was also somewhat lower by 2.6 %. A statistically significant positive difference has recorded in the study of mineral metabolism. The level of phosphorus and calcium in the blood serum of birds from the experimental group was significantly higher than control by 4.1 % (for phosphorus) and 7.8 % (for calcium) (P <0.05). The level of nonspecific resistance of the organism of birds in the experimental group was statistically significantly higher in comparison with the indices of the control group. So, the bactericidal activity of blood serum in the experimental group was higher than control by 9.2 % (P <0.05), lysozyme activity was statistically higher than control by 6.0 % (P <0.05).

Thus, the use of a feed supplement in the diet of birds helps to increase metabolic processes, in particular protein and mineral, while improving the course of fat, by reducing cholesterol in the blood of quail of the experimental group, and also increase the immune status of quail. A negative effect of the use of a biological product on the morphobiochemical condition of the quail's blood not revealed.

Effect of feed additives on digestion

The digestibility analysis of nutrient components of feed is in Table 4.

The conducted balance experiment showed that the use of feed additives in the diet of quail positively affects the digestibility of feed components. So, it has found that in the experimental group, the digestibility of organic matter was higher than in the control group by 6.7 %. The crude

protein amount ate by birds from the experimental group more than the control group by 5.9 %. The fat amount of compound feed digested by quail of the experimental group was also more than the control group by 4.9 %. Crude fiber, although it is slightly absorbed by the bird, in the experimental group, its digestibility was higher than in the control group by 4.8 %. It also revealed a slight increase in the digestibility of nitrogen-free extractives of compound feed by the experimental group's quails compared with the control group by 3.9 %.

Table 4: Digestibility of nutrients of compound feed, %.

Nutrient	Group	
	Control	Experienced
Organic matter	56,98±1,64	63,73±1,54
Crude protein	54,54±1,49	60,42±1,56
Crude fat	78,58±1,52	83,47±1,67
Crude fiber	32,64±0,76	37,45±0,87
Nitrogen-free extractive substances	42,54±0,74	46,47±0,81

To study the effect of the feed additive Albit-BIO on the qualitative and quantitative composition of the microbial fauna of the gastrointestinal tract of quail, microbiological analyses of the blind's chyme processes of the intestines of the studied birds were carried out. The results are in Table 5.

Table 5: Microbial balance of the quail intestine chyme (n = 10).

Indicators	Group	
	Control	Experienced
Lactobacillus, 10^8 CFU / g	1,2±0,03	4,2±0,03*
Bifidobacterium, 10^7 CFU / g	0,9±0,03	2,7±0,04*
Escherichia, 10^2 CFU / g	4,5±0,05	2,5±0,04*
Enterococcus, 10^2 CFU / g	1,1±0,02	–
Pseudomonas, 10 CFU / g	–	–
Staphylococcus, 10^2 CFU / g	1,1±0,02	0,4±0,01*
Streptococcus, 10^2 CFU / g	3,5±0,06	2,7±0,02*
Clostridium, 10 CFU / g	–	–

* Significant difference with control (P < 0,05).

Microbiological analysis of the chyme of the blind processes after using the feed additive showed a statistically significant difference between the experimental group and the control. Thus, when analyzing the content of lactic acid bacteria, it was found that in the blind processes of birds of the experimental group, their titer was significantly higher than in control 3.5 times (P <0.05). The number of active bifidobacteria in the experimental group was higher than in control 3.0 times with a statistically significant difference (P <0.05). It has recorded the absence in the blind processes of quail of all groups of representatives of clostridia and pseudomonas. A statistically significant decrease in the active forms of Escherichia in the experimental group of quail has recorded in comparison with the control group by 1.8 times (P <0.05). In the experimental group on nutrient media, no growth of streptococci has detected, while in the control group, the value of this indicator has observed. Also, the experimental group revealed a statistically significant decrease in the number of staphylococci and streptococci representatives.

Thus, the fungal autolysate has a positive effect on feed components digestibility and stimulates the growth of beneficial microflora. There has found that reduce the growth of opportunistic microbiota, which contributes to the best increase in the live weight of the experimental bird.

Quails' meat productivity and the development of their internal organs

A study of the meat productivity of quails after using a feed additive at the age of 56 days in their diet is in Table 6.

Table 6: Meat quail productivity (n = 10).

Index	Group	
	Control	Experienced
Live weight of the bird before slaughter, g	325,76±2,12	347,35±2,12*
The mass of the carcass after bleeding, g	316,31±2,01	336,58±2,06*
The mass of unsqueezed carcass without feathers, g	295,79±1,98	314,69±2,03*
The mass of gutted carcass, g	243,66±1,86	263,63±1,68*
Pectoral muscles, g	70,68±0,71	78,76±0,75*
Mass of femoral muscles, g	25,40±0,53	28,13±0,63
Shin muscles, g	12,37±0,31	14,04±0,39
The remaining muscles, g	12,05±0,45	14,71±0,47
Total edible muscle, g	120,50±1,21	136,27±1,17*

* Significant difference with control (P < 0,05).

As a result of the slaughter, it has found that the carcass weight after bleeding in the experimental group remained statistically significantly higher than in the control group by 6.4 % (P <0.05). A similar trend has observed for other indicators. So, the difference with the control group was also significant in the analysis of an unbroken carcass without feathers. The mass of which in the experimental group exceeded the control by 6.4 % (P <0.05). The most massive muscles of the body in quail are pectoral, the mass of which was significantly higher in the experimental group than in the control group by 11.4 % (P <0.05). Also, in the experimental group, there was a statistically significant difference in the weight of all the bird's body muscles relative to the control group, which was higher by 13.4 % (P <0.05).

The effects of the biological product used on the mass of

various organs and the accumulation of intracavitary fat of quail are in Table 7.

Table 7: Mass of internal organs and in-band fat, g (n = 10).

Index	Group	
	Control	Experienced
Lungs	3,32±0,10	3,38±0,09
Liver	8,35±0,33	8,39±0,30
A heart	3,51±0,07	3,58±0,08
Muscle stomach	6,17±0,21	6,34±0,19
Glandular stomach	1,18±0,03	1,26±0,04
Intestines	11,29±0,34	11,43±0,32
Intracavitary fat	2,57±0,07	2,21±0,08

The results of weighing the internal organs of quail of all groups showed no significant differences. The difference in mass of individual organs was not substantial and was not pathological but was associated with a change in body weight. In general, the bulk of internal organs was physiologically normal. When studying the mass of intracavitary fat, no statistically significant difference has recorded. However, it should be has noted that this indicator in the experimental group tended to decrease by 14.0 % compared with the control group. In our opinion, part of the fat by the bird of the experimental group connected with a more active metabolism was used as an energy source to maintain metabolic processes.

Thus, using feed additive Albit-BIO in quail diet contributes to increasing poultry meat productivity and improve the quality of obtained quail products.

Evaluation of the quail meat quality

The analysis of the chemical composition of the quail muscles of all groups is in Table 8.

Studying the chemical composition of the foot and pectoral muscles of the quail of the experimental group showed superiority compared with the control group, but without a significant difference. It has revealed that in the experimental group's quail muscles, the moisture content was slightly lower than in the control group by 0.44 % (foot) and 1.56 % (pectoral). The protein amount into the foot muscles of quail from the experimental group was higher than control by 0.92 %, and into the pectoral muscles by 1.7 %. The amount of fat in the flesh of birds in the experimental group decreased slightly compared to the control. An important indicator characterizing the dietary property of meat products is the meat quality index, which was lower in quail in the experimental group than in the control group by 9.1 % (leg muscles) and also by 14.3 % (pectoral muscles).

Table 8: The chemical composition of quail muscles (n = 10).

Index	Group	
	Control	Experienced
Leg muscles		
Moisture%	72,18±1,24	71,74±1,18
Protein%	22,43±0,51	23,35±0,46
Fat%	4,87±0,14	4,38±0,12
Ash%	0,52±0,02	0,53±0,02
Meat Quality Index (MQI)	0,22	0,19
Pectoral muscles		
Moisture%	71,38±0,98	69,82±0,96
Protein%	24,67±0,75	26,37±0,71
Fat%	3,34±0,07	3,17±0,09
Ash%	0,61±0,02	0,64±0,02
Meat Quality Index (MQI)	0,14	0,12

The biological usefulness of quail meat products also evaluated by the content of especially significant essential amino acids of bird muscle protein Table 9.

Table 9: Amino acid composition in quail muscles, mg / g.

Amino acid	Group	
	Control	Experienced
Leg muscles		
Lysine	45,1±0,5	47,2±0,4
Tryptophan	26,2±0,2	28,2±0,4
Phenylalanine	53,2±0,5	54,9±0,7
Leucine	62,4±0,5	63,6±0,6
Methionine	34,4±0,3	35,2±0,4
Pectoral muscles		
Lysine	49,5±0,6	51,6±0,5
Tryptophan	31,5±0,5	32,8±0,4
Phenylalanine	55,4±0,6	57,3±0,4
Leucine	64,6±0,4	66,5±0,7
Methionine	36,3±0,4	37,6±0,3

Assessment of the amino acid composition of quail muscles showed that the studied essential amino acids in the experimental group slightly exceeded the analogs in the control group. It has found that in the foot muscles of the experimental group's birds, the content of lysine, tryptophan, phenylalanine, leucine, and methionine was higher than in control by 4.7; 7.6; 3.2; 2.0 and 2.3 %. In the pectoral muscles of birds of the experimental group, the content of the studied essential amino acids was also higher than in the control group. So, in the experimental group, the lysine level exceeded the control by 4.2 %, the amount of tryptophan by 4.1 %. In the context of the studied groups in the pectoral muscles, a similar picture has revealed in the

content of phenylalanine, leucine, and methionine.

Thus, mushroom autolysate's use improves the chemical composition of poultry muscles while reducing the fat and protein index, as well as lowering the meat quality index, increases the dietary property of meat products, and their bio-value due to amino acid composition.

CONCLUSIONS AND RECOMMENDATIONS

The research results showed that the feed additive "Albit-BIO," which is an autolysate of the fungus Cephalophora Tropical biomass, contains many microelements. Its use in the quail diet has a stimulating effect on the metabolism and immune status of birds. An increase in growth and preservation has established in comparison with the control. Increasing the digestibility of feed components is probably associated with the stimulation of the growth of beneficial and lower titer of pathogenic microflora of the gastrointestinal tract. At the same time, the study of meat quality showed an increase in nutritional and biological indicators.

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AUTHORS CONTRIBUTION

Andrei Koshchayev is a scientific leader and research developer. Albina Luneva is the developer of a new feed supplement. Kurban Murtazaev is the developer quail diet. Yury Lysenko studied biochemical and microbiological parameters. Ruslan Omarov studied meat productivity and meat quality.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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