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ORIGINAL ARTICLE

Digestibility of nutrients by young geese for use of lithium in the composition of fodder

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In recent years, applied research has been carried out to determine the physiological needs of poultry in mineral elements, which were not previously taken into account in rations, but, as has been proven, have a positive influence on their organism. One of these bioelements is lithium. Numerous experimental studies conducted on different types of animals and poultry, allowed to identify sufficiently broad and diverse biological properties of lithium salts. The discovery of the biological properties of lithium became the basis for its use in the poultry industry. Already the first attempts to use lithium in zootechnical practice allowed to get results, which prove the need to develop differentiated norms of introducing it into the feed for poultry of different species, age and direction of productivity. One of the evaluation criteria, in determining the physiological need of poultry in lithium, is the level of digestibility of feed nutrients in the organism. In the physiological experiment on goslings of the Legart breed, the effect of the addition of different doses of lithium in compound feeds on the degree of digestibility of nutrients in their bodies was studied. It was established that all doses of lithium entering into the combined feed, which were tested, generally had a positive effect on the digestive processes in the body of goslings, but their effectiveness was different. According to the degree of digestibility of nutrients of the feed, they differed favorably from poultry of other groups, the goslings of the fourth experimental group were fed with lithium-enriched feed at the rate of 0.15 mg/kg. In poultry of this group, the digestibility of organic matter was 1.4% ($P<0.05$); crude protein-by 1.5 ($P<0.01$); crude fat-by 0.8; crude fiber-by 2.3 and nitrogen-free extractives-by 1.0% ($P<0.05$) higher than that of the goslings of the control group.
Keywords: Goslings; lithium; dose, nutrients; digestibility

Introduction

Poultry farming is the most dynamic and highly efficient livestock industry in many countries around the world, which besides the stable provision of the population with high quality dietary food products, promotes the development of technologically related fields and industries and forms the basis for the socio-economic development of rural areas (Kuppusamy, 2015).

Among the numerous elements of the technological process, which provide high living capacity of the poultry and the maximum realization of its genetic potential, an important role is given to full-fledged feeding, which involves the complete satisfaction of the individual need for poultry in exchange energy, the main nutrient and biologically active substances, including microelements.

The microelements in the body activate the action of many enzymes, vitamins and hormones, and thus ensure the normal functioning of various biological systems, the implementation of numerous physiological and biochemical reactions and, as a consequence, affect the productive quality of farm poultry (Richards et al., 2010). The trace elements can not be synthesized in the body or replaced by other substances, and therefore the main source of their entry into the body of the poultry is feed. The trace elements are introduced into feed for poultry in the form of guaranteed additives, excluding their content in feed components (Taylor-Pickard & Tucker, 2005).

By implementing detailed feeding standards, it is foreseen that only seven trace elements (Mn, Fe, Zn, Cu, Co, I, Se) are introduced into the feed for different types of poultry (Bratishko et al., 2013). However, according to scientists, the list of trace elements used in feed for different types of poultry is clearly insufficient.

In recent years, applied research has been carried out to determine the physiological needs of poultry in mineral elements, which have not previously been taken into account in diets, but have proven to have a positive effect on the body. To such bioelements, which, according to scientists, are subject to compulsory normalization, belongs also lithium. According to the classification based on the biological role for living organisms and widely used in biochemistry and physiology, lithium is a group of conditionally essential elements (Prashanth et al., 2015). However, today it is considered by scientists as a "serious candidate for essentials" (Poljanskaja, 2014; Bauer & Gitlin, 2016).

Numerous experimental searches conducted on different species of animals and poultry have allowed to reveal rather wide and diverse properties of lithium salts. It has been established that lithium compounds have anti-stress and adaptogenic properties (Miftahutdinov, 2013; Ostrenko et al., 2018). In experiments on pigs and poultry, the antiviral properties of lithium in relation to the virus of reproductive and pigs respiratory syndrome of type II (PRRSV) (Cui et al., 2015), parvovirus of pigs (PPV) (Chen et al., 2015), transmissive Porcine Gastroenteritis (TGEV) (Ren et al., 2011), the poultry infectious bronchitis virus (IBV) (Harrison et al., 2007), the poultry leukemia virus of the subgroup J (ALV-J) (Qian et al., 2018). Some lithium compounds have antibacterial properties in relation to bacterial species such as Staphylococcus aureus SH1000, Pseudomonas aeruginosa PA01 and Escherichia coli O157:H7 (Khalid et al., 2014; Stachelska, 2015). In the literature there is evidence that lithium exhibits antitumor and anti-metastatic activity (Kaufmann et. al., 2011; Maeng et al., 2016). There are direct clinical evidence of antioxidant lithium activity (Belousovaa et al., 2011; Khairova et al., 2012; Plotnikov et al., 2016). Lithium plays an important role in the functioning of the immune system (Rybakowski, 1999; Maddu & Raghavendra, 2015).

Biochemical mechanisms of action of lithium are multifactorial and related to the action of many enzymes, hormones, vitamins and transcription of genes regulating growth and development. Today, the biochemical effects and mechanisms of action of lithium salts are intensively studied, but they are still not completely elucidated (Mikosha et al., 2017).

The discovery of the biological properties of lithium has become the basis for its use in poultry farming. In veterinary medicine, lithium is used to prevent and correct "technological" stress during vaccination (Lukichjova, 2008), deactivation (Anosov & Miftahutdinov, 2015), transplantation and transport of young poultry (Abdullaev, 2015; Miftahutdinov, 2013). In zootechnics, lithium aqueous solutions are used for pre-incubation aerosol treatment of eggs in order to enhance their elimination and elimination of young (Belousovaв et. al., 2011). Enrichment of mixed fodder for young livestock of different species of farmed poultry contributes to increasing their live weight, preservation and efficiency of their feed use (Bachinskaja, 2009; Grybanova & Sobolev, 2015). The introduction of lithium into compound feed positively affects the slaughter and meat qualities of young poultry, in particular, it contributes to the increase of the mass of half-carcass and patrons of carcasses, as well as edible parts of carcasses (Grybanova & Sobolev, 2013). The feeding of poultry of mixed fodder with lithium additions improves the quality of meat products, in particular, the organoleptic parameters of meat and bouillon (Lukichjova, 2011), contributes to the enrichment of the muscle tissue, liver and heart of the poultry with this trace element (Homchenko & Naumova, 2005). Under the influence of lithium, the profile of irreplaceable and substitute amino acids in the muscles of the chest and the feet of the poultry, which increases the relative biological value of the meat (Borovkov et al., 2010).

As is clear from the foregoing, the first attempts to use lithium in the zootechnical practice have allowed to obtain results which prove the absolute necessity of determining the optimal differentiated rates for the introduction of it into fodder for poultry of different species, age and productivity. In developing and substantiating the optimal rates of lithium in feed for poultry, one should evaluate not only its productive qualities, but also the basic processes of stepwise enzymatic cleavage and absorption of nutrients in the gastrointestinal tract. The question of the influence of lithium on the degree of use of certain groups of nutrients (proteins, fats, carbohydrates) in the body of the poultry in the process of digestion have important theoretical and practical value, because they allow us to expand our knowledge of its biological role and to explain the data obtained in experiments.

Analysis and synthesis of literature data made it possible to conclude that there are no experimental data on the influence of different levels of lithium in mixed fodders on the degree of digestibility of the main nutrients in the body of poultry, including young geese. In this regard, the purpose of our research was to study the effects of additives of various doses of lithium in feed on the degree of digestibility of nutrients in the body of young geese.

Materials and methods

The research was conducted on young geese of the Legard breed. For the physiological experiment 5 young geese were chosen into control and experimental groups at 30 days of age. The experiment consisted of two periods-preliminary and main. Groups were formed on the principle of analogues, taking into account the live weight and origin of the young for the same ratio in the groups of males and females. The poultry was kept in special cages, which were adapted for harvesting the poultry dung.

Feeding of young geese of all groups during the physiological experiment was carried out with dry, complete feeding fodders in accordance with the existing norms. The young geese of the first control group did not receive the lithium supplement. Poultry of the second experimental group in the mixed feed were additionally injected with lithium at the rate of 0.05 mg/kg, the third-0.10 and the fourth-0.15 mg/kg.

During the main period (5 days) a careful accounting of consumed feed and allocated poultry dung was carried out. Poultry dung was collected twice a day: in the morning and in the evening. The collected poultry dung was weighed and samples were taken for analysis. The fixation of ammonia of each sample of the poultry dung was carried out by pouring 0.1 N solution of oxalic acid at a rate of 4 ml per 100 g of homogenized mass of the poultry dung. Prior to the conduct of the zootechnical analysis, all samples of the poultry dung were stored in the refrigerator in a glass, tightly closed container. Selection of medium samples of mixed fodders was carried out at the beginning of the main period (DSTU ISO 6497:2005, 2008). Medium Samples were stored in polyethylene bags.

The amount of digestible nutrients was determined by the difference between their receipt with food and the allocation of

them with poultry dung. In determining the digestibility of crude protein the method, based on the chemical method of separating nitrogenous substances of feces from nitrogenous substances of urine (Maslieva, 1967) was used.
The chemical analysis of mixed fodders, the poultry dung was carried out using the following methods: total humidity-by drying the weight gain to constant mass in the drying cabinet (DSTU ISO 6496:2005, 2006); raw protein-by Kjeldal (DSTU ISO 5983-1:2014, 2015); raw fat-extraction with ethyl alcohol in the Soxhlet apparatus (DSTU ISO 6492:2003, 2005); raw fiber-by intermediate filtering (DSTU ISO 6865:2004, 2004); crude ash-by ozonation of swabs in a muffle furnace (DSTU ISO 5984:2004, 2005).
The content of nitrogen-free extract (NFE) in mixed fodders and poultry dung was determined by calculation, by difference between 100 and the sum of the percentages of all other feed materials or poultry dung.
The number of digested herbs of organic matter of feed was calculated by the formula:

$$K=A-(B-C),$$

where K-the digested organic matter of the feed, g; A-organic matter of food, g; B-organic matter of the poultry dung, g; C-organic substance of urine, g.
In mathematical analysis of the results of the research, it was used PAM and computer programs of statistical processing of Microsoft Excel. The difference between the groups was estimated according to Student's criterion and Fisher's criterion (in a dispersion analysis) and was considered probable with the values: *-P<0.05; **-P<0.01.

Results and discussion

The amount of used fodder during the main period of the physiological experiment and data on their chemical composition allowed to establish that by quantity of basic nutrients, which on average a day went to the body of young geese, there were no significant differences between youngers of control and experimental groups (Table 1).

Table 1. Average Daily Consumption of Nutrients of Young Geese Feed, g/head.

Index	Group			
	1 control	**2 experimental**	**3 experimental**	**4 experimental**
Organic matter	224.1 ± 0.89	225.1 ± 1.05	223.9 ± 1.65	225.9 ± 1.53
Raw protein	49.5 ± 0.20	49.9 ± 0.23	49.7 ± 0.37	49.7 ± 0.34
Crude fiber	12.3 ± 0.05	11.9 ± 0.06	12.2 ± 0,09	12.1 ± 0.08
Raw fat	9.4 ± 0.07	9.3 ± 0.04	9.3 ± 0.07	9.2 ± 0.06
NFE	152.8 ± 0.61	154.0 ± 0.72	152.6 ± 1.13	154.9 ± 1.05

Thus, the actual consumption of organic matter by the young geese of the control group averaged over one day per day was 224.1 g; raw protein-49.5; crude fiber-12.3; raw fats-9.4 and nitrogen-free extract (NFE)-152.8 g. Similar indices in their peers from the experimental groups varied in the following limits, g: 223.9-225.9; 49.7-49.9; 11.9-12.2; 9.2-9.3 and 152.6-154.9 respectively. It should also be noted that the differences between the groups in actual consumption of nutrients did not have a certain regular connection with the doses of lithium introduced into the feed.
Subsequent mathematical calculations, based on the obtained results, made it possible to identify and detail the nature of the changes in digestibility of the main nutrients of fodder in the poultry of experimental groups under the influence of lithium supplements.
The results of the data presented in Table 2 showed that all doses of lithium which was tested had a generally positive effect on the degree of digestibility of the nutrients of fodder.

Table 2. Digestibility of nutrients of mixed fodders,%.

Index	Group			
	1 control	**2 experimental**	**3 experimental**	**4 experimental**
Organic matter	72.8 ± 0.27	73.1 ± 0.30	73.2 ± 0.41	74.2 ± 0.47*
Raw protein	81.2 ± 0.19	81.8 ± 0.20	82.4 ± 0.27**	82.7 ± 0.32**
Crude fiber	61.1 ± 0.39	61.8 ± 0.43	62.1 ± 0.58	61.9 ± 0.70
Raw fat	47.5 ± 0.53	48.8 ± 0.57	49.7 ± 0.77*	49.5 ± 0.93
NFE	80.8 ± 0.19	80.5 ± 0.22	80.5 ± 0.30	81.8 ± 0.33*

Notes: probability of difference between control and research groups according to Student's criterion: *-P<0.05; **-P<0.01.

Thus, the young geese of experimental groups were better to digest the organic matter of mixed fodder (73.1-74.2%, against 72.8% in the control group). However, the statistically significant (P<0.05) difference was only in the fourth experimental group, whose youngers exceeded this indicator of their peers from the control group by 1.4%.
More significant differences were detected by digestion of crude protein. In particular, in youngers of the second experimental group, in comparison with the control group, this indicator was higher by 0.6%, the third one-by 1.2 (P<0.01) and

the fourth-by 1.5% (P<0.01) and respectively amounted to 81.2%, 82.4% and 82.7%. In the poultry of experimental groups there was a tendency to increase the digestibility of crude fat by 0.7-1.0%, compared with the young geese of the control group, where the similar indicator was 61.1%. The youngers of the control group conceded to the experimental also on digestion of crude fiber. The difference between the control and experimental groups (in favor of the latter) was: in the second-1.3%, in the third-2.5 (P<0.05) and the fourth-2.3%.
Concerning the digestion of non-nitrogenous extractives, the second and third experimental groups of the young geese slight insignificant decrease in the value of this indicator was noted at 0.3%, while in the youngers of the fourth experimental group, on the contrary, the increase was 1.0% (P<0.05), compared to the control group (80.8%).
In order to check the existing differences between the groups according to the average digestibility of nutrients of compound feeds and establishing the force of communication between the resultant sign and the individual levels of the factor that were studied, we conducted a dispersion analysis. The results confirmed that different doses of lithium produced a mixed but positive effect on the digestibility of the main nutrients of the feed in the body of the young geese (Table 3).

Table 3. Strength of influence of various doses of lithium on the digestibility of nutrients of mixed fodder with young geese.

Index	**Lithium dose, mg/kg**					
	0.05		**0.1**		**0.15**	
	η^2_x	**%**	**η^2_x**	**%**	**η^2_x**	**%**
Organic matter	0.051	5.1	0.093	9.3	0.505*	50.5
Raw protein	0.408*	40.8	0.698**	69.8	0.725**	72.5
Crude fiber	0.163	16.3	0.249	24.9	0.126	12.6
Raw fat	0.297	29.7	0.459*	45.9	0.339	33.9
NFE	0.144	14.4	0.102	10.2	0.499*	49.9

Notes: Probability of difference between control and experimental groups according to Fisher's criterion: *-P <0.05; **-P <0.01.

It was established that the dose of lithium 0.15 mg/kg on the strength of the effect on some indicators of digestibility of nutrients in the feed significantly differed from other doses. For example, strength of influence of this dose on the digestibility of organic matter, crude protein and NFE was high and amounted respectively to 50.5% (P<0.05), 72.5 (P<0.01) and 49.9% (P<0.05). Also, quite high, though statistically improbable, was the effect of this dose on the digestibility of crude fiber. The factor contribution is 33.9%.
Other doses of lithium (0.05 and 0.10 mg/kg) conceded a dose of 0.15 mg/kg based on the force of influence of the studied digestibility. The lowest force of influence practically on almost all indicators of digestibility of nutrients of feed was characteristic for a dose of lithium 0.05 mg/kg.

Conclusion

All doses of lithium introduction into the mixed feed that was tested, in general, had a positive effect on the digestive processes of young geese in the body, but their effectiveness was different. According to the degree of digestibility of nutrients of feed, they favorably differed from their analogues from the control and other experimental groups, the young geese of the fourth experimental group, fed with mixed fodder enriched with lithium at a rate of 0.15 mg/kg.

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