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THE USE OF VARIOUS SOURCES OF POTASSIUM IN GROWING BROILERS

ИСПОЛЬЗОВАНИЕ РАЗЛИЧНЫХ ИСТОЧНИКОВ КАЛИЯ ПРИ ВЫРАЩИВАНИИ ЦЫПЛЯТ-БРОЙЛЕРОВ

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Аннотация: *В проведенных исследованиях показана сравнительная эффективность применения калия хлорида и калия карбоната для улучшения продуктивности цыплят-бройлеров кросса «Смена 8». Показано, что как хлорид, так и карбонат калия может включаться в комбикорма для цыплят-бройлеров с целью повышения продуктивности и улучшения конверсии корма. Применение хлорида калия в дозе 1,5 кг/т корма способствовало увеличению живой массы бройлеров в 34-дневном возрасте на 3,52% при снижении затрат корма на 1 кг прироста живой массы на 3,1%. Анализ содержания золы, кальция и фосфора в костяке бройлеров не выявил существенных различий между опытной и контрольной птицей. Уровень содержания влаги в помете цыплят всех групп был на уровне 60,0–60,7%.*

Abstract: *The studies show the comparative efficiency of the use of potassium chloride and potassium carbonate to improve the productivity of broilers cross "Smena 8". It was shown that both chloride and potassium carbonate can be inserted into compound feeds for broilers in order to increase productivity and improve feed conversion. The use of potassium chloride in a dose of 1.5 kg / t of feed contributed to the increase in live weight of broilers at 34 days aged by 3.52% while reducing the cost of feed by 1 kg of increase in live weight by 3.1%. Analysis of the content of ash, calcium and phosphorus in the skeleton of broilers did not reveal significant differences between the experimental and control birds. The moisture content in the litter of chickens of all groups was at the level of 60.0–60.7%.*

Ключевые слова: *цыплята-бройлеры, источники калия, продуктивность, баланс электролитов.*

Key Words: *broilers, potassium sources, productivity, electrolyte balance.*

Introduction

The modern poultry farming are making high demands on production of quality, balanced compound feeds to help intensify metabolic processes in high yielding stock [1, 2]. Optimal balance of electrolyte - sodium, potassium and chloride - play a crucial role in developing compound feed formulations as they maintain water and ion balances. A normal pH in the blood and extracellular fluid is in a narrow range between 7.35 to 7.45 (45-35 nmol/L) due to the presence of body's chemical buffer systems. The main buffer system in the blood plasma is the bicarbonate system. The body is properly protected from pH changes in the acidic direction. Plasma bicarbonates that are able to neutralize acidic metabolic products dumped into the blood are called alkaline reserve of the blood. Sodium and potassium increase the pH and HCO3 in the plasma, whereas chlorine decreases their values, thus when one plans poultry diets, primarily the total electrolyte balance should be considered.

Compound feeds used are usually deficient in those necessary elements as calcium, phosphorus and sodium and require addition of their sources in their composition, i.e. limestone or shells, feed phosphates, table salt or alternative sources of sodium, and fish meal. There are standard potassium contents, but compound poultry feeds are hardly ever deficient of potassium, so it is added in recipes mainly to maintain electrolyte balance (plant-based feedstuffs contain from 1 to 2.3% of potassium and this amount is considered sufficient to cover the needs of the body).

Potassium sources for poultry are soybean meal, nutritional yeast and food processing by-products. The birds' diet must contain a certain amount of potassium to maintain a balance of electrolyte ions. Chicks require from 2.3 to 4 g/kg of potassium, turkey poults - 6 g/kg. Potassium deficiency results in poor growth rate, muscle weakness, decreased intestinal tonus, and cardiac disorders in birds [3]. It was found that potassium cations reduce accumulation of free lysine in muscles and liver, increase its concentration in blood plasma and absorption rate in animals' and birds' body, which benefits protein synthesis. According to available evidence, supplementation of potassium may increase growth rates, particularly as it can decrease antagonism between some amino acids.

Application of potassium carbonate at 2-3 kg/t of feed proved advantageous for improved productivity in broilers; this is supported with studies carried out on broiler chicks by the All-Russian Scientific Research and Technology Institute for Poultry Industry of the Russian Academy of Sciences (VNITIP) [1]. In the studies the live weight of broilers that received 2-3 kg/t of potassium carbonate in their feed exceeded the reference by 2.42 and 2.34% by the end of the fattening period, while the cost of feed per kg of weight gain reduced by 1.32%; this is consistent with other research on positive effect of potassium supplementation on poultry productivity and feed conversion efficacy. It was proved that 1 to 3 kg/t of potassium carbonate can be added to broiler diet to reduce supplementation with synthetic lysine, improve productivity and increase feed conversion efficacy [4, 5].

It was found that addition of 1 and 2 kg/t potassium into compound feeds benefits live weight gain in chicks in trial groups at 35 days of age by 6.57 and 8.39% respectively, with lower feed consumption per kg of live weight [6].

There is literature evidence of the advantages of supplementation of 1-2 kg/t potassium carbonate to improve productivity of laying hens and other livestock [7, 8, 10].

A logical question arises: is it possible to replace potassium carbonate with sodium carbonate for the same application and will it be equally beneficial? There is no doubt that, unlike potassium chloride, potassium carbonate is essential for a better electrolyte balance and prevention of heat stress. At the same time, good solubility of potassium chloride in water allows adding it into drinking water and efficiently prevent negative effects of stress factors. In this context a comparative study of efficacy of various potassium sources used for feeding broilers is certainly of interest for poultry farming from the scientific and practical point.

Materials and methods

The experiment took place in the vivarium of SGC "Zogorskoye", FSC VNITIP RAS with four groups of Smena 8 cross-bred broiler chickens at 1 to 34 days of age.

Broilers in the control group consumed balanced compound feed varieties (main diet) with nutritional values as recommended by VNITIP [1]. The dietary electrolyte balance (*DEB*) of the compound feed was 16.97 mgEq/100 g for the trial group of 1-21-day-old chicks, and 15.86 mgEq/100 g for 22-34-day-old chicks.

Chicks in group 2 received 1.5 kg/t of potassium chloride in their compound feed additionally to their main diet, and group 3 broilers received a similar level of potassium carbonate. Birds in trial group 4 received potassium chloride in drinking water of 1.5 kg/1000 l water.

The groups were assigned using a matching method, the birds were fed *ad libitum*, the feeds were distributed by hand.

The broilers were kept in P-15 type cages gender-inclusive, 35 birds in each group, in compliance with requirements for cage density, trough and watering space, and length and intensity of light. During the

experiment the basic livestock indicators relevant for broilers were taken into account: live weight at the age of 7, 14, 21, and 34 days (through individual weighing of the flock), survival rate, daily average live weight gain, consumption and cost of feedstuffs per kg of live weight gained, calcium, phosphorus and potassium contents in the skeleton.

The experimental data obtained were processed by analysis of variance using Student's t-test. Differences at $p \leq 0.05$ were considered significant.

Research results

Feed potassium chloride has good solubility in water, contains 52% of potassium and 46.54% of chlorine, and demonstrates good technological properties. It does not deteriorate electrolyte balance in the diet caused by increase in potassium contents. As the results of broiler rearing show in Table 1, addition of 1.5 kg/t of potassium chloride to compound feed for chicks in trial group 2 helped increase their live weight by 2.6% and 3.7% at 7 d and 14 d of age as compared to the control group.

It was found that it would be more reasonable to use potassium chloride in an aqueous solution than in feeds as dry supplement at early ages. So, potassium chloride solution in 1.5 kg/1000 l water when drunk increased live weight of broilers by 0.71% in trial group 4 at 14 d of age as compared to chicks in trial group 1 that received potassium chloride in the equal amount in dry feed. In the following age periods chicks in trial group 2, that received potassium chloride with compound feed grow better than broilers in trial group 4 that received potassium chloride with drinking water.

Broilers' live weight in group 2 was credibly higher by 7.85% aged 21 days and by 5.27% aged 28 days. Broilers in group 4 exceeded the control group by 1.11 and 3.98% at the same age.

It should be noted that chicks in trial group 3 that received potassium in its carbonate form showed better productivity before they aged 28 days as compared to trial group 2 that received the same amount of potassium in the form of chloride with feed. Chicks in trial group 3 that received 1.5 kg/t of potassium carbonate demonstrated greater live weight by 8.31% than the control group at the age of 14 days, by 14.02% at the age of 21 days, and by 8.69% at the age of 28 days; the difference was significant at $p \leq 0.001$.

Table 1

Results of broiler rearing

Indicator	Group			
	1 (K)	2 Supplements (1.5 kg/t KCl)	3 Supplements (1.5 kg/t K2CO3)	4 Addition to drinking water (1.5 g/l KCl)
Survival rate, %	100	100	100	100
Live weight, g, at age, days:				
7	141.73±1.32	145.48±5.5	143.68±1.44	143.79±1.43
14	399.36±4.55	414.17±6.02	432.56±6.412	417.11±6.101
21	796.57±15.12	859.14±13.542	908.23±14.972	805.42±11.90
28	1,376.62±19.5	1,449.12±19.381	1,496.26±24.222	1,431.47±18.77
34	1,915.45	1,982.96	1,993.78	1,936.83
including cockerels	2 022.91±55.99	2,121.35±30.0	2,134.0±37.50	2,061.50±28.03
pullets	1,808.0±25.20	1,844.56±26.83	1,853.55±35.00	1,812.16±30.34
Feed consumption per head, kg	2.863	2.930	2.889	2.900
Feed intake per kg of live weight gain, kg	1.560	1.513	1.496	1.539
Daily average gain of live weight, g	56.77	58.82	59.14	57.42

Note. [1] $p \leq 0.5$; [2] $p \leq 0.001$.

Table 2

Calcium, phosphorus and potassium contents in the skeleton of 35-day-old broilers

Indicator	Group			
	1 (C)	2	3	4
Crude ash, %	51.63	51.70	51.73	51.69
Calcium, %	20.65	20.64	20.78	20.54
Phosphorus, %	8.41	8.40	8.52	8.45
Potassium, mg/%	0.352	0.354	0.355	0.350

However, by the end of fattening period the productivity of chickens became equal regardless of the form of potassium they received. Specifically, the average live weight in trial group 2 was 1.09% higher than that in trial group 3 (insignificant difference); and only in terms of feed conversion were birds in trial group 2 inferior to trial group 3 - lower by 1.14% .

In general, broilers in all trial groups receiving potassium salts demonstrated improved productivity at the end of fattening period as compared to the control group. So, the live weight of broilers in groups 2, 3 and 4 was higher by 3.52; 2.43% and 1.12%; with less feed intake per kg of live weight gain by 3.01; 4.1 and 1.35%, respectively.

Assays for calcium, phosphorus, and potassium in the broilers' skeleton did not found significant differences in mineral storage between birds in the control and trial groups (*Table 2*).

So, potassium chloride and potassium carbonate used during broiler rearing in the amount of 1.5 kg/t of feed does not affect negatively survival of experimental birds and does not influence moisture of litter, which was almost the same in all groups – 60.0-0.7%.

Conclusions

The results showed that potassium chloride, similarly to potassium carbonate, may be added to broiler diet in order to improve their productivity and feed conversion.

Addition of potassium chloride in the amount of 1.5 kg/t of feed boosts live weight gain of broilers at 34 days of age by 3.52 with lower feed consumption per kg of live weight gain by 3.1% as compared to the control group.

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