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Efficiency of using mixed feeds with different levels of lysine and methionine for growing turkeys

Oleksii Tymoshchuk*
Doctoral Student
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0009-0002-4209-7835
Serhii Hryshchenko
PhD in Agricultural Sciences, Associate Professor
National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine
https://orcid.org/0000-0003-2286-0776

Abstract. The purpose of the study was to investigate the effect of feeding complete mixed feeds with different levels of lysine and methionine on the growth of young turkeys. Experimental studies were performed on young meat turkeys of the BIG 6 cross. Based on the method of balanced groups, five experimental groups of day-old poultry were established. The experiment lasted 126 days and was divided into two periods: equalising (7 days) and main (119 days). During the equalising period, the experimental young animals consumed mixed feed of the control group. During the main period of the experiment, the amount of lysine and methionine relative to the mixed feed of poultry of the control group for the rearing periods decreased or increased proportionally by 5% and 10%. It was found that different levels of lysine and methionine in mixed feeds for young turkeys affect their productivity in different ways. At the age of 126 days, turkeys that received mixed feed with an increase in the amount of lysine and methionine by 5% and 10% had the highest live weight – they outnumbered the analogues of the control group by 5.9% ($p < 0.01$) and 3.6%, respectively. Young animals that consumed mixed feed with a reduced amount of lysine and methionine in this indicator were inferior to their control peers by 5.6% ($p < 0.05$) and 2.7%, respectively. An increase in the level of lysine and methionine by 5% and 10% in mixed feed of turkeys at all stages of their growth helps to reduce feed costs per 1 kg of live weight gain by 4.3% and 2.1%, respectively. It is proved that the relationship

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*Corresponding author

between the levels of lysine and methionine in mixed feed for young turkeys and its costs per 1 kg of live weight gain is described by a polynomial line with a reliable approximation coefficient $R^2 = 1$. Correlation analysis shows that there is a significant ($p < 0.05$) strong inverse relationship between these two indicators ($r_s = -0.82$). The poultry liveability index in all experimental groups was close (94-96%), but the probable influence of different levels of lysine and methionine in mixed feed during poultry rearing on its liveability indicator was not established

Keywords: feeding; poultry; amino acids; feed consumption; liveability

Introduction

In the field of poultry farming, one of the main tasks is to ensure high productivity through efficient use of feed. Raising turkeys requires a detailed approach to the development of the diet, especially in terms of the level of essential amino acids such as lysine and methionine. Due to the increased productivity of modern turkey crosses, producers can get more products in a shorter period of time, which contributes to increased profitability. However, the high growth rate of birds is not always accompanied by an improvement in their health, which requires careful monitoring and optimisation of growing conditions. In industrial production at poultry farms, turkeys are exposed to various technological factors and pathogens that can be transmitted through feed, water, and air. Given the limited use of antibiotics in poultry farming, losses due to this can be minimised by increasing the immunity of birds and accelerating the development of the immune system. Amino acids are components with immune-boosting functions, and some of them (arginine, lysine, methionine) also regulate various key metabolic processes. However, the levels of various amino acids, in particular, lysine and methionine, in turkey feeding are now causing a lot of discussion and controversy. According to NRC recommendations (4), they specify lower levels of these amino acids than those offered by the manufacturer of modern turkey crosses British United Turkeys Ltd.

Numerous studies by various researchers and manufacturers have proven that different levels of lysine and methionine for feeding young turkeys at different stages of growth can significantly affect both their productivity and immune status, and the indicators of economic efficiency of production. That is why the issues of investigating the efficiency of using mixed feeds with different levels of lysine and methionine for growing turkeys of modern crosses in the industrial conditions of farms in Ukraine are relevant and important. J. Jankowski *et al.* (2020) evaluated the effect of different dietary ratios of arginine, methionine, and lysine on turkey performance, immune status, and meat quality. The results of the study showed that the correct ratio of these amino acids not only increases the growth rate and quality of meat, but also has a positive effect on the immune system, which helps to improve the overall health of birds. A.O. Oso *et al.* (2017) determined the effect of different levels of arginine and methionine in the diet of turkeys with high lysine content. They found that changes in the levels of these amino acids significantly improved the birds' performance, particularly muscle growth and bone development. Improved immunity and bird health were important additional results of this study.

P. Konieczka *et al.* (2022) attempted to assess the effect of elevated levels of arginine, lysine, and methionine in the diet of turkeys on their performance, intestinal integrity, and immune status under various conditions. The purpose of their study was to determine how increasing the levels of these amino acids in compound feeds can improve the health and productivity of birds, especially in conditions of stress or disease. The results of the study showed that increasing the levels of arginine, lysine, and methionine in the diet of turkeys has a positive effect on their

performance, in particular, on the growth rate and development of muscle mass. In addition, these amino acids help to improve intestinal integrity, which is important for the normal absorption of nutrients and maintaining the overall health of birds. D. Murawska *et al.* (2018) investigated the effect of various sources of methionine in the diet of turkeys on their productivity and meat quality. The purpose of their study was to determine how different sources of methionine affect the growth rate and quality of meat, in particular, its texture and taste properties. The results showed that methionine sources have a significant impact on the quality of meat, improving its taste characteristics and the overall productivity of birds.

N. Dyshliuk & N. Mazur (2024) evaluated the effect of different levels of lysine and methionine in mixed feed on the productivity and quality of turkey meat. The results showed that optimising the levels of these amino acids in the diet of turkeys improves their growth rate, muscle mass development, and meat quality. In particular, the study pointed to the importance of the balance between lysine and methionine in achieving high productivity and improving the physiological parameters of birds, which is crucial for poultry farming. V.S. Bomko *et al.* (2023) in their study drew attention to the efficiency of the use of feed and feed additives for animal feeding. The purpose of their study was to investigate the effect of various feed additives on animal productivity. The results showed that the use of specialised feed additives can significantly increase the efficiency of feed use, improve the growth rate and overall health of animals. The study highlighted the need for a proper selection of feed additives to ensure optimal development of farm animals. The purpose of the study by C. Chang *et al.* (2024) was to investigate the effect of total protein and lysine levels in the diet on meat quality and myofibrile characteristics in slow-growing chickens. The results showed that correction of protein and lysine levels in the diet of chickens affects the quality of meat, in particular, the texture and taste characteristics. The study also pointed to the importance of providing appropriate levels of these nutrients to improve meat quality in slow-growing birds.

However, previous studies have not fully addressed the effect of different levels of these amino acids on specific economic indicators, such as feed costs per unit of live weight gain and production efficiency at different stages of growth. In addition, there is no data on the impact of changes in lysine and methionine levels on the liveability of birds in industrial conditions. This paper fills in these gaps by investigating the relationship between lysine and methionine levels in mixed feed for young turkeys and feed costs per 1 kg of live weight gain.

The purpose of the study was to determine the efficiency of rearing young meat turkeys of the BIG 6 cross at different levels of lysine and methionine in mixed feeds.

Materials and Methods

Scientific and economic experiment was carried out according to the method of balanced groups at the Limited Liability Company "Industrial Exposition Company Adventure" of the Polonsky district of Khmelnitsky Oblast in 2024. All experimental studies were conducted in accordance with modern methodological approaches and in compliance with the relevant requirements and standards, in particular, they meet the requirements of DSTU ISO/IEC 17025:2005 (2006). The animals were kept and all manipulations were carried out in accordance with the provisions of the Procedure for conducting experiments and experiments on animals by scientific institutions (Law of Ukraine No. 249, 2012), the European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (1986).

According to the experiment scheme (Table 1) at the day-old age, 500 turkeys were selected, of which 5 groups were formed according to the principle of analogues – control and 4 experimental, 100 animals each. The experiment lasting 126 days was divided into two periods: equalising (age of the bird – 1-7 days) and main (8-126 days).

Table 1. *Scheme of the scientific and economic experiment*

Age, weeks (days)	Content in 100 g of mixed feed, %	Group				
		1	2	3	4	5
Equalising period						
1 (1-7)	Lysine	1.76	1.76	1.76	1.76	1.76
	Methionine	0.63	0.63	0.63	0.63	0.63
Main period						
2-3 (8-21)	Lysine	1.76	1.58	1.67	1.85	1.94
	Methionine	0.63	0.57	0.60	0.66	0.69
4-6 (22-42)	Lysine	1.57	1.41	1.49	1.65	1.73
	Methionine	0.56	0.51	0.54	0.59	0.62
7-10 (43-70)	Lysine	1.33	1.2	1.27	1.39	1.46
	Methionine	0.49	0.44	0.47	0.51	0.54
11-12 (71-84)	Lysine	1.09	0.98	1.03	1.14	1.19
	Methionine	0.42	0.38	0.40	0.44	0.46
13-14 (85-98)	Lysine	0.97	0.87	0.92	1.02	1.07
	Methionine	0.40	0.36	0.38	0.42	0.44
15-18 (99-126)	Lysine	0.86	0.77	0.82	0.90	0.95
	Methionine	0.37	0.33	0.35	0.39	0.41

Source: compiled by the authors

During the scientific and economic experiment, rations were used that ensured normal viability and high productivity of poultry, in accordance with the established norms and recommendations of the producer (Nutrient Requirements of Poultry..., 1994; Feeding guidelines for..., 2015; Management guidelines for..., 2022). In the experiment, the free-range feeding was used, meaning that the bird regulated its total feed intake. Multiplicity of feed distribution – twice a day (morning and evening) with simultaneous accounting of the remaining feed. The ratio of lysine to methionine in mixed feeds was regulated by the introduction of synthetic amino acids.

Experimental livestock was kept indoors on the floor with a density of 5 turkeys per 1 m^2. The bedding was made of peat. Access to water was free. Starting from Week 7, young turkeys were released from the premises during the day to paddocks, the area of which was at the rate of 7 m^2 per animal. The live weight of turkeys was determined by individual weighing. The liveability of the livestock was determined daily by the number of culled and dead birds.

Feed consumption was accounted daily, for each period of growth and for the entire period of experiment. At the end of each period and experiment, the total consumption of mixed feed per 1 kg of live weight gain was calculated using the equation:

$$C_F = \frac{A_F}{I}, \quad (1)$$

where C_F – feed consumption per 1 kg of live weight gain, kg; A_F – amount of feed fed for the accounting period, kg; I – gross increase in live weight for the accounting period, kg. Data processing was carried out using MS Excel and STATISTICA software using built-in statistical functions.

Results and Discussion

During the scientific and economic experiment young turkeys were fed complete mixed feeds (Table 2), with the following nutritional value (Table 3). The level of lysine and methionine in mixed feeds at all stages of growth was different and this was regulated by the introduction of synthetic amino acids. It was found that different levels of lysine and methionine in mixed feeds for young turkeys during rearing affect their growth indicators in different ways. Thus, at the end of the experiment at the age of 126 days, turkeys of the Group 4 (13.45 kg) and the Group 5

(13.15 kg) had the highest live weight, which exceeded the analogues of the control Group by 753 ($p < 0.01$) and 455.5 g, respectively. Turkeys of Group 2 and Group 3 had a lower live weight compared to the control Group by 706.3 ($p < 0.05$) and 337.2 g, respectively.

Table 2. *Composition of complete mixed feeds for young turkeys of the control group, % by weight*

Component	Period, weeks					
	1-3	4-6	7-10	11-12	13-14	15-18
Wheat	29.30	25.66	24.59	24.00	24.99	24.00
Corn	13.00	20.01	26.00	29.94	38.00	45.12
Soybean oilcake	45.82	41.40	37.46	29.89	24.30	15.22
Sunflower oilcake	-	3.88	4.91	9.64	6.00	9.23
Fish meal	6.80	4.29	1.63	-	-	-
Soybean oil	-	0.50	1.41	2.81	3.02	3.55
Lysine monochlorohydrate	0.26	0.25	0.26	0.18	0.21	0.29
DL-methionine	0.22	0.15	0.17	0.10	0.15	0.11
L-threonine	0.04	0.05	0.04	0.03	-	-
Table salt	0.3	0.13	0.21	0.24	0.25	0.24
Monocalcium phosphate	1.26	1.22	1.29	1.31	1.08	0.82
Lime flour	2.30	1.76	1.36	1.21	1.36	0.78
Sodium bicarbonate	0.10	0.10	0.10	0.10	0.10	0.10
Mycosorb A+	0.10	0.10	0.07	0.05	0.04	0.04
Natuzyme (enzyme+phytase)	0.005	0.005	0.005	0.005	0.005	0.005
Premix	0.495	0.495	0.495	0.495	0.495	0.495

Source: compiled by the authors

Table 3. *Content of essential nutrients and energy in 100 g of mixed feed, %*

Indicator	Period, weeks					
	1-3	4-6	7-10	11-12	13-14	15-18
Exchange energy, MJ	11.91	12.21	12.74	13.19	13.45	13.83
Crude protein	27.43	26.00	23.30	20.98	18.02	16.00
Crude fat	5.60	7.00	7.17	7.82	7.58	8.47
Crude fibre	3.11	4.21	3.80	4.50	4.60	4.73
Calcium	1.45	1.29	1.14	0.96	0.86	0.77
Phosphorus	0.74	0.65	0.51	0.47	0.43	0.39
Lysine*	1.76	1.57	1.33	1.09	0.97	0.86
Methionine*	0.63	0.56	0.49	0.42	0.40	0.37

Note: * content of lysine and methionine in poultry feed of experimental groups varied according to the experiment scheme
Source: compiled by the authors

During the entire growth period, there is a change in the feed composition depending on the age of the birds. For example, the content of wheat decreases, while corn, on the contrary, increases, which indicates a shift in focus on more energy components, as the energy needs for turkey growth increase over time. Soybean oilcake decreases in the feed composition, while sunflower oilcake appears only at later stages, which allows meeting protein needs. Fish meal, which is an important source of protein, is gradually reduced and eliminated from the diet in the last stages, which is normal, since birds can get protein from other sources.

The levels of amino acids, in particular lysine and methionine, are adjusted depending on the age of birds. In the early stages of rearing, the content of lysine and methionine in feed is higher,

and with the age of birds, this level decreases, as the needs for these amino acids change. This allows optimising the feed, providing birds with the necessary amount of amino acids at each stage of their development. Changes in the content of additives such as table salt, monocalcium phosphate, and lime flour are also adjusted depending on the needs of birds for calcium and phosphorous substances, which is important for bone development, especially during periods of active growth. Microelements and premix used throughout the entire period support the stability of physiological processes and the health of birds.

The cost of mixed feed for the production of any product, including in turkey growing, significantly affects its cost and significantly depends on the level of poultry productivity and the amount of mixed feed consumed (Kidd & Kerr, 1998). The data provided (Table 4) showed that with an increase in the content of lysine and methionine in mixed feed, its consumption decreases by 1 kg of live weight gain.

Table 4. *Feed consumption per 1 kg of live weight gain of turkeys, kg, n = 100*

Experiment period, days	Group				
	1	2	3	4	5
1-7	1.605	1.644	1.593	1.674	1.589
8-14	1.279	1.319	1.318	1.245	1.291
15-21	1.488	1.555	1.508	1.440	1.466
22-28	1.414	1.440	1.429	1.383	1.404
29-35	1.499	1.588	1.568	1.446	1.481
36-42	1.628	1.581	1.551	1.557	1.643
43-49	1.456	1.476	1.484	1.403	1.437
50-56	1.758	1.813	1.801	1.650	1.682
57-63	1.773	1.932	1.868	1.782	1.706
64-70	2.317	2.195	2.132	1.913	2.057
71-77	2.461	2.648	2.540	2.392	2.504
78-84	3.023	3.239	3.104	3.054	2.968
85-91	3.067	3.157	3.033	2.650	2.741
92-98	3.531	4.022	3.902	3.449	3.685
99-105	3.462	3.757	3.696	3.461	3.350
106-112	4.718	5.902	5.111	4.418	4.487
113-119	4.926	5.897	5.539	4.553	4.696
120-126	5.392	5.656	5.600	4.536	4.833
For the entire period of experiment	2.691	2.850	2.765	2.537	2.597

Source: compiled by the authors

Analysis of Table 4, which provides data on the consumption of mixed feed per 1 kg of live weight gain of turkeys for different groups during the entire experiment period, shows an interesting trend in the relationship between the level of lysine and methionine in mixed feed and the efficiency of bird feeding. The costs of mixed feed per 1 kg of live weight gain for five groups of turkeys that were at different feeding levels are presented. The most noticeable trend is a decrease in feed costs with an increase in the level of lysine and methionine in mixed feeds, which indicates an improvement in the efficiency of feed use when optimising these amino acids. For example, Group 4, which probably had the most optimised lysine-methionine ratio, had the lowest feed consumption per 1 kg of live weight gain during all experiment periods. This confirms the conclusion that the correct balance of amino acids allows reducing feed costs, which directly affects the cost of production.

During the entire experiment period, feed costs per 1 kg of live weight gain were lowest in Group 4, which is 6.1%, 12.3%, 9.0%, and 2.4% less than in groups 1, 2, 3 and 5, respectively. This indicates that Group 4 had the best results in terms of feed efficiency, which can be attributed to proper correction of lysine and methionine levels in the diet. Groups with lower levels of these amino acids had higher feed costs for live weight gain. In general, the table confirms that increasing the lysine and methionine content in mixed feed is an effective strategy for reducing feed costs and increasing the economic efficiency of turkey rearing, as they provide more efficient use of feed for poultry growth. The high feed costs observed in some groups indicate the need to optimise amino acid levels to achieve better results.

The efficiency of using mixed feed is supplemented by determining the relationship between the level of lysine and methionine in mixed feed and its consumption per 1 kg of live weight gain (Fig. 1).

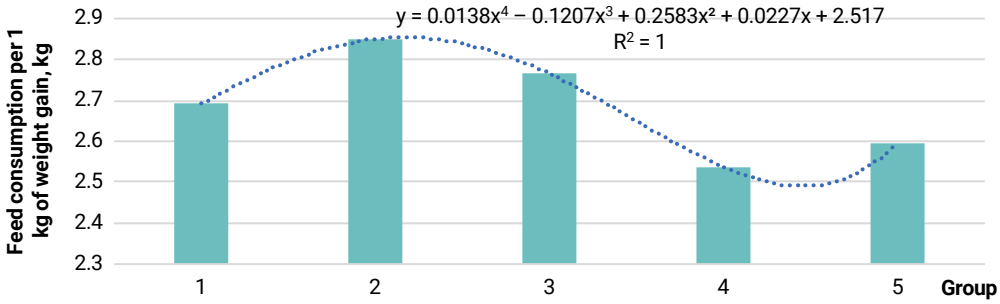

Figure 1. *Relationship between lysine and methionine levels in mixed feed and feed costs in young turkeys*

Source: compiled by the authors

From the data in Figure 1, it can be seen that there is a significant inverse relationship between the level of these amino acids in mixed feed and feed costs. In particular, correlation analysis indicates a strong inverse relationship ($r_s = -0.82$), which is statistically significant ($p < 0.05$). This means that with an increase in the level of lysine and methionine in mixed feed, the amount of feed required to achieve an increase of 1 kg of live weight in young turkeys decreases. In other words, the higher the level of lysine and methionine in the diet of birds, the more efficiently they use food for growth. This confirms the efficiency of increasing the content of these amino acids in mixed feeds to achieve more economical rearing of turkeys. This inverse relationship is a useful indicator for poultry farming, as it reduces the cost of mixed feed, which helps to reduce production costs and increase production efficiency (Kogut, 2009). The figure highlights the importance of optimising lysine and methionine levels to achieve maximum results with minimal feed costs.

Notably, the liveability of experimental young turkeys during the entire experiment period was quite high and ranged from 94-96% (Table 5).

Table 5. *Liveability of young turkeys, % of the number at the beginning of the experiment, n = 100*

Experiment period, days	Group				
	1	2	3	4	5
1-7	98	99	99	98	98
8-14	98	98	97	98	98
15-21	97	97	97	97	97

Table 5. *Continued*

Experiment period, days	Group				
	1	2	3	4	5
22-28	96	97	97	97	97
29-35	96	96	97	97	97
36-42	96	96	96	97	96
43-49	96	96	96	96	96
50-56	96	95	96	96	96
57-63	96	95	95	96	96
64-70	95	95	95	96	96
71-77	95	94	95	96	96
78-84	95	94	95	95	96
85-91	95	94	95	95	96
92-98	95	94	95	95	96
99-105	95	94	95	95	96
106-112	95	94	95	95	96
113-119	95	94	95	95	96
120-126	95	94	95	95	96
For the entire period of experiment	95	94	95	95	96

Source: compiled by the authors

The liveability of young turkeys remained quite high over time, which indicates the overall stability and good condition of the birds in the rearing process, regardless of the group. Throughout the experiment, Group 5 showed the highest bird liveability, retaining 96% at the final stage. Group 2 had the lowest liveability rate, which was 94% by the end of the experiment. Other groups (1, 3, and 4) had intermediate results, which also indicates fairly stable bird survival rates in these groups. Despite these differences in liveability among the groups, the study did not reveal a significant effect of lysine and methionine levels in mixed feed on this indicator. That is, changes in the levels of these amino acids did not have a significant effect on the level of bird survival, which indicates their irreplaceable role in improving other aspects of productivity, such as growth and development, but does not affect the survival of birds as much.

Discussion of the results shows that the results of the current study are in the context of scientific advances in poultry farming and feed efficiency, in particular, regarding the effects of amino acids such as lysine and methionine on poultry productivity. Research by C.-C. Fang *et al.* (2021) demonstrated a positive effect of increased methionine levels on the growth and development of muscle mass in fish, which correlates with the results of the current study, where an increase in lysine and methionine levels in compound feeds had a positive effect on live weight gain in young turkeys. Both studies point to the importance of optimising amino acids in animal diets to achieve better growth outcomes. The study by N. Yousefi & S. Abbasi (2022), which focuses on improving the solubility and thermal stability of feed proteins, can also be consistent with the results of the current study in the context of the importance of feed quality to ensure high productivity. Although the focus of this study on protein stability was not part of the current analysis, high feed quality is an integral part of successful animal rearing, which is supported by the results of both studies.

The study by M. Li *et al.* (2022), who investigated the relationship between collagen characteristics and meat tenderness, is also important for comparison, although the main focus of the current study was on performance indicators. However, both studies highlight the importance

of feed additives to improve final products, in this case, to achieve high poultry productivity, and in the case of these researchers – to improve meat quality. The relationship between lysine and methionine levels and product quality is an important aspect for further research in both directions. The study by M. Hastie *et al.* (2022), which focused on consumers' perception of meat and the impact of ageing methods on its quality, has a different focus and is more concerned with consumer preferences than the production aspects explored in the current paper. The results of the current study, which focuses on productivity and cost-effectiveness, can help in further work that considers the perception of final products by consumers.

The effect of quercetin on meat tenderness and apoptosis and autophagy signalling pathways described by T. Wang *et al.* (2022) and Y. Wang *et al.* (2022), supplemented the understanding of the efficiency of feed additives. Although the study focused on antioxidant properties and effects on autophagy in chickens, its results may be consistent with the results of the current study in the context of overall feeding efficiency, which includes not only amino acids, but also other supplements that affect the health and productivity of animals. The researchers noted that quercetin can improve meat tenderness due to its effect on metabolic processes in muscle tissue, in particular, by regulating apoptosis and autophagy, which are important for maintaining muscle health and overall health in birds. This study also highlights the importance of an integrated approach to the selection of feed additives, which includes not only amino acids, but also antioxidants and other bioactive components that can positively affect the productivity and quality of meat. In the current study, increased levels of lysine and methionine in turkey feed have shown a positive effect on live weight gain and feed consumption, but it is also important to consider additional additives, such as antioxidants or other biologically active components, which may have an additional impact on improving meat quality and overall health of birds.

According to C. Werner *et al.* (2008), feed additives are important for improving the efficiency of animal feeding, which is consistent with the results of the current study, which showed a positive effect of increased levels of lysine and methionine on the productivity of turkeys. The study by these researchers confirms the need to optimise feed to improve animal productivity, which is the main goal of the current study, where the effect of different levels of amino acids on live weight gain and feed consumption are investigated. According to the results of the current study, increasing the level of lysine and methionine in mixed feeds contributes not only to better growth of poultry, but also to optimisation of feed costs, which directly affects the reduction of production costs. These factors are critical for improving the economic efficiency of production and ensuring sustainable growth of turkeys in industrial conditions.

C. Chang *et al.* (2024) investigated the effect of protein and lysine levels on meat quality and myofibrile characteristics in slow-growing chickens. Although their study focused on the meat qualities of poultry rather than its performance, the results confirmed the importance of adjusting lysine levels in the diet to achieve the desired results. This is consistent with the current study, where it was demonstrated that an increase in lysine levels in mixed feed has a positive effect on live weight gain in turkeys. Although the study focuses on aspects of meat quality, these results can be useful for improving turkey feeding to improve the quality of meat products and feed efficiency, which ensures optimal results at different stages of growth.

The study by I. Cherevko (2023) and T. Vahsen *et al.* (2021) examined the effects of increased arginine, lysine, and methionine levels on turkey performance, health, and immunity. Both studies demonstrated a positive effect of increased amino acid levels on improving bird growth, which is consistent with the results of the current study. Increasing the level of lysine and methionine in mixed feeds really helps to improve live weight gain and feed efficiency,

which is confirmed by research results. However, the studies note that the effect of increasing amino acids may depend on the keeping conditions, which is an important aspect for further research.

P. Glatz & B. Rodda (2013) addressed the welfare and maintenance of turkeys, in particular focusing on the conditions of keeping, feeding, and the impact of these factors on bird productivity. The importance of creating comfortable conditions for turkeys, including appropriate temperature conditions, sufficient space for movement, and a balanced diet, was emphasised. It was noted that physical and psychological stress can significantly affect the health and productivity of birds, so special attention should be paid to the well-being in the process of raising them. This study is related to the current research, as it also examines feeding and its impact on turkey productivity.

The current study focuses on the effect of lysine and methionine in mixed feed on live weight gain and feed consumption, whereas P. Glatz & B. Rodda (2013) focuses more on an integrated approach to keeping conditions and feed efficiency in terms of animal welfare. Both studies highlight the importance of a balanced approach to keeping and feeding turkeys to achieve high productivity. An important aspect is that although the researcher focuses on creating comfortable conditions for birds, the current study focuses more on optimising feed composition and the effect of specific amino acids, such as lysine and methionine, on physiological growth and productivity indicators. The results of both studies are consistent with the need to provide turkeys with a balanced diet to achieve the best growth and health results.

The results of the current study are consistent with other papers confirming the importance of optimising lysine and methionine levels in mixed feeds to achieve high productivity and cost-effectiveness. In particular, the data provided confirm that changes in the levels of these amino acids can positively affect live weight gain and reduce feed costs. Comparison with other studies allows expanding the understanding of the impact of feed additives on various aspects of cultivation and product quality, which can become the basis for further research in this area.

As a result of the scientific and economic experiment, the effect of various levels of lysine and methionine in mixed feed on the productivity and health of young turkeys was investigated. An increase in the content of lysine and methionine in mixed feed contributed to an improvement in the growth rate of birds, in particular, turkeys of groups 4 and 5 reached the highest live weight at the end of the experiment. Optimisation of the levels of these amino acids helped to reduce feed costs by 1 kg of live weight gain, which increases the economic efficiency of cultivation. The most cost-effective feed was Group 4, where the optimised lysine-methionine ratio showed the best results.

The liveability of birds throughout the experiment remained high (94-96%), which indicates stable keeping conditions. However, lysine and methionine levels did not significantly affect this indicator, confirming that these amino acids do not directly affect the survival of birds, but significantly improve other aspects of their performance. The results of the study highlight the importance of adjusting the levels of lysine and methionine in mixed feeds to achieve high growth rates and reduce feed costs, which contributes to improving the efficiency of poultry farming.

Conclusions

The results of the study confirmed that an increase in lysine and methionine levels by 5% and 10% in mixed feed for young turkeys leads to a significant increase in their live weight at 126-day age. In particular, an increase in lysine levels by 5% provided an increase in live weight by 5.9%, and an increase in methionine by 10% – by 3.6% ($p < 0.01$). A decrease in these amino acids in mixed feed by 10% and 5% led to a decrease in the live weight of birds by 5.6% and 2.7%, respectively ($p < 0.05$). This demonstrates the importance of a balanced approach to adjusting dietary amino acid levels for optimal bird growth.

The study also indicates that an increase in lysine and methionine levels in mixed feeds by

5% and 10% at all stages of cultivation contributed to a reduction in feed costs per 1 kg of live weight gain by 4.3% and 2.1%, respectively. Analysis of the relationship between the level of lysine and methionine in mixed feed and feed costs per 1 kg of growth showed a strong inverse relationship (rs = -0.82), confirming that with an increase in the content of these amino acids, the amount of feed required to achieve bird growth decreases. However, correlation analysis revealed a significant inverse relationship between the level of amino acids and feed costs for live weight gain, which demonstrates the importance of the right balance for reducing feed costs and improving economic efficiency. As for the liveability indicators, the study did not reveal a significant effect of different levels of lysine and methionine on this parameter, since the level of liveability of birds remained consistently high and did not depend on changes in amino acid levels. This suggests that amino acids may have a positive effect on bird productivity, but their effect on survival is not significant.

Prospects for further research may focus on investigating the effects of different levels of lysine and methionine in mixed feed on the yield and quality of slaughter products, and on the possibilities of optimising the levels of these amino acids to improve the quality of meat and other indicators important for poultry farming. In addition, it is necessary to investigate the effect of various methods of introducing synthetic amino acids into mixed feeds on their efficiency and on the possibility of integrating such approaches into industrial production to reduce costs and increase the overall productivity of birds.

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None.

Conflict of Interest

None.

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Ефективність використання комбікормів з різними рівнями лізину і метіоніну за вирощування індиків

Олексій Тимощук

Здобувач наукового ступеня доктора філософії
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0009-0002-4209-7835

Сергій Грищенко

Кандидат сільськогосподарських наук, доцент
Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна
https://orcid.org/0000-0003-2286-0776

Анотація. Метою статті було дослідити вплив згодовування повнораціонних комбікормів з різними рівнями лізину та метіоніну на ріст молодняку індиків. Експериментальні дослідження виконано на молодняку індиків м'ясного напряму продуктивності кросу BIG 6. За методом збалансованих груп у добовому віці було сформовано п'ять піддослідних груп птиці. Дослід тривав 126 діб та поділявся на два періоди: зрівняльний (7 діб) та основний (119 діб). У зрівняльний період піддослідний молодняк споживав комбікорми контрольної групи. В основний період досліду кількість лізину і метіоніну відносно комбікорму птиці контрольної групи за періодами вирощування зменшувалась або збільшувалась пропорційно на 5 і 10 %. Встановлено, що різні рівні лізину і метіоніну у комбікормах для молодняку індиків позначаються на його продуктивності по-різному. У 126-добовому віці найвищу живу масу мали індики, які отримували комбікорм із збільшенням кількості лізину і метіоніну на 5 і 10 % – вони переважали аналогів контрольної групи відповідно на 5,9 ($p < 0,01$) і 3,6 %. Молодняк, який споживав комбікорм із зменшеною кількістю лізину і метіоніну за згаданим показником поступалася перед контрольними ровесниками відповідно на 5,6 ($p < 0,05$) і 2,7 %. Збільшення рівня лізину і метіоніну на 5 і 10 % у комбікормі індиків на усіх етапах їх вирощування сприяє зниженню витрат корму на 1 кг приросту живої маси відповідно на 4,3 і 2,1 %. Доведено, що залежність між рівнями лізину й метіоніну у комбікормі для молодняку індиків та його витратами на 1 кг приросту живої маси описується поліноміальною лінією з коефіцієнтом достовірної апроксимації $R^2 = 1$. Кореляційний аналіз свідчить, що між цими двома показниками існує достовірний ($p < 0,05$) сильний зворотній зв'язок ($r_s = -0,82$). Показник збереженості птиці у всіх піддослідних групах був близьким (94-96 %), проте вірогідного впливу різних рівнів лізину і метіоніну у комбікормах за вирощування птиці на показник її збереженості не встановлено

Ключові слова: годівля; птиця; амінокислоти; витрати корму; збереженість