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Increasing Resistance and Productivity of Broiler Chickens through Probiotics

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Abstract: A series of experiments were conducted at the poultry farm "Sary-Bulak" in the Almaty region in 2023. The objective was to determine the effect of a probiotic supplement, developed based on the connection of strains of lactic acid bacteria, on live weight, average daily gain, livestock safety, feed costs per unit of live weight gain, meat quality of carcasses and economic efficiency in growing young meat poultry. A total of five groups were formed, comprising one control group and four experimental groups, with each group comprising 100 heads. The chickens in the experimental groups were fed a mixed fodder diet with different dosages of probiotic supplement, with group 1 serving as a control. All technological parameters pertaining to the growth of meat chickens were in accordance with the recommendations for the utilization of probiotic supplements in poultry farming. The research demonstrated that the utilization of varying doses of probiotic supplements in mixed fodders resulted in an increase in the final live weight of broiler chickens by 4.7-12.8% in comparison to the standard diet. The optimal dose for young meat chickens was 0.15 mL/kg in the first week and 0.45 mL/kg throughout. This resulted in a 13.1% increase in daily weight gain and a 6.6% improvement in livestock safety. Furthermore, the additive enhanced the nutritional value of the meat, with selenium and iodine levels rising by 6.8 and 2.3 times, respectively. The results of the economic analysis indicated that the experimental group exhibited a 1.5-fold increase in profitability. It is therefore recommended that 0.45 mL/kg of probiotic supplement be incorporated into mixed fodder in order to enhance meat productivity and quality.

Keywords: Cross, Growth, Live Weight, Probiotic

Introduction

In recent years, a number of biologically active feed additives have become widely used in poultry farming, alongside a range of other factors including the enhancement of livestock safety, the improvement of feed quality, and the optimization of poultry housing conditions. This is due to their regulatory effect on the intensity of digestion and utilization of feed nutrients, which allows for the targeted management of these processes (Alpeisov, 2019; Alpeisov, 2020; Myktybayeva *et al*., 2019).

The efficacy of specific feed additives in poultry farming is frequently acknowledged by numerous authors, as evidenced by the findings of scientific research. Nevertheless, the enhancement of productive indices does not invariably ensure the economic viability of employing specific feed additives.

In this regard, the problem of researching the effectiveness of feed additives and pro-biotics, positively affecting the productivity of poultry with a simultaneous increase in the quality of products and reducing the pathogenic effects of the environment is relevant, has a scientific and practical interest (Alpeisov, 2021; Andrianova, 2012; Egorov, 2012; Kundyshev and Kuznetsov, 2013; Tulemissova *et al*., 2020).

The market currently offers a wide variety of biologically active feed additives. However, despite the plethora of biologically active feed additives available for

use in poultry diets, a significant proportion of the market is occupied by those additives that enhance immunity to disease, facilitate optimal growth and development of young animals, and enhance the safety of livestock (Alpeisov, 2020; Kumganbayeva, 2020; Moldahmetova, 2020). Research work conducted by us on meat chickens using a probiotic supplement developed on the basis of associated strains of lactic acid bacteria showed good zootechnical results (Boranbayeva *et al*., 2020; Torehanov *et al*., 2021).

The objective of the research was to examine the growth and development indicators, as well as meat productivity of meat chickens at the introduction of different doses of probiotic supplements into mixed fodders.

Beneficial probiotics accelerate digestive processes in animals, while also improving the balance of cecal microorganisms and nutrient absorption in broiler chickens (Anee *et al*., 2021). The steady interest of scientists in the research of lactic acid bacteria is due not only to the fact that they perform a great multifaceted role in the life of the animal's organism. Researchers are particularly interested in such biological properties as adhesive, antagonistic, immunoregulatory, cytoprotective, cholesterol-utilizing activity, phage resistance, and bacteriocinnogenesis (Tulemisova *et al*., 2015). To be considered probiotic, a microorganism must be nonpathogenic, capable of providing a viable cell count, positively affecting the host's health, and enhancing intestinal tract functions. Some of the most frequently utilized probiotics are Lactobacillus acidophilus, Lactobacillus lactis, Lactobacillus plantarum, Lactobacillus bulgaricus, Lactobacillus casei, Lactobacillus helveticus and Lactobacillus salivarius. Other common strains include Bifidobacterium species, Enterococcus faecium, Enterococcus faecalis, Streptococcus thermophilus, and Escherichia coli, along with probiotic fungi like Saccharomyces cerevisiae and Saccharomyces boulardii (Al-Shawi *et al*., 2020).

Potential probiotic strains typically need to possess the ability to influence the host's immune system or physiological functions, reduce the virulence of specific pathogens, help manage or prevent infections and inflammatory conditions, and serve as biological control agents to curb spoilage (Arsène *et al*., 2021).

It is well established that lactic acid bacteria play a role in the cleaning of the gastrointestinal tract of poultry from putrefactive microflora, thereby contributing to improved digestibility of feed. It is well established that the intensive use of poultry in conditions of high livestock concentration and significant anthropogenic impact is accompanied by a decrease in body resistance, increased morbidity, and a lethal outcome (Ushakova *et al*., 2012).

The successful development of poultry farming is contingent upon the implementation of rigorous veterinary welfare standards and the utilization of appropriate chicken breeding technology. The absence or lack of certain vital biologically active substances in poultry diets has a negative impact on the bioresource potential of the animals.

Currently, research is being conducted with the objective of determining the potential benefits of incorporating production-valuable strains of lactobacilli with increased biological activity into poultry diets. Lactobacilli are one of the additives actively involved in the digestive processes of poultry and play a crucial role in enhancing immune function. They boost the body's defense mechanisms, including accelerating the regeneration of mucous membranes. Additionally, they promote the production of antibodies against related harmful microorganisms, stimulate phagocytosis, and trigger the synthesis of lysozyme and interferons (Abd El-Hack *et al*., 2022).

In recent years, there has been a growing interest in veterinary medicine in biological preparations, with a particular focus on those of bacterial origin (Tulemisova *et al*., 2015).

In light of the above, research into the biological and technological properties of local strains of lactobacilli with a view to utilizing them as probiotics for the feeding of farm animals and birds is both relevant and timely.

In the context of the rapid expansion of poultry farming, the quality of the products and their ecological purity represent a crucial and determining criterion. Concurrently, the role of scientific support for such production technologies, with the guarantee of the safety of the produced products for humans, is increasing (Adzhigirova, 2001; Alpeysov, 2019).

Probiotics have emerged as a popular alternative to antibiotic growth promoters in poultry production due to their ability to enhance the host's gut health and immune system. They offer multiple benefits, including improving disease resistance, modulating gene expression to reduce heat stress, and enhancing the overall quality and productivity of poultry. Researchers are continuing to explore ways to optimize probiotics' impact on poultry, focusing on improving their integration within the bird's body and utilizing bacterial metabolites for further gains (Darboe, 2022).

Wide and active use of antibiotics in medicine and poultry farming for decades has contributed to the accumulation of research material on adverse reactions caused by them. Thus, it is established that the effect of antibiotics is closely connected with the change of intestinal microflora, manifested in the form of dysbacteriosis; vitamin deficiency in the body; secondary infections caused by antibiotic-resistant forms of pathogens; and the manifestation of allergic reactions. Many antibiotics (streptomycin, penicillin, and their derivatives) introduced into mixed fodder and used for 5-7 days, accumulate in meat and internal organs of birds.

Probiotic bacteria play a critical role in digestion and nutrient absorption by producing enzymes such as amylase, lipase, and protease. Beyond digestion, they enhance immune function by modulating the body's immune response and influencing gut microbial activity. Clinical trials have demonstrated that live probiotics help protect the intestinal lining and act as natural antagonists, reinforcing the gut as a defense barrier (Zaidi *et al*., 2024).

Growing concerns about the side effects of antibiotics used therapeutically, combined with the push to eliminate their use as growth promoters in poultry, have driven both consumers and producers to explore alternative solutions (Adli *et al*., 2021).

A key consideration in poultry feeding is the use of modern bioactive substances of bioorganic origin, which positively influence the health and well-being of the animals.

Antibiotics can negatively impact the growth of beneficial lactic acid bacteria, particularly when they enter food through treated farm animals. This interference with probiotic microflora during food production can diminish food quality and potentially encourage the emergence of antibiotic-resistant microorganisms. In case of irrational treatment of humans and farm animals with antibiotics, the activity of beneficial microflora is suppressed, causing an increase in the number of pathogenic and potentially dangerous human and farm animal microorganisms in the intestine. Therefore, the selection of microbial cultures for probiotic preparations and food products based on them is of great importance for such properties as resistance to antibiotics (Myktybayeva *et al*., 2019).

Although the concept of introducing beneficial bacteria into poultry is not new, research has yet to fully determine the best practices for their application. A significant discovery in probiotics was that administering gut contents from healthy adult chickens to newly hatched chicks can prevent colonization by Salmonella enteritidis, a process known as competitive exclusion. However, as poultry productivity has increased, so has the rise of pathogens and bacterial resistance, partly due to excessive use of chemotherapeutic agents. To maintain low-cost, high-quality poultry production, growth stimulants are necessary that maximize poultry's genetic potential while safeguarding human health.

The primary method for administering probiotics on poultry farms is through feed, though other methods are also used, such as gavages, sprays, tablets, granules, capsules, or powders. Increasingly, farmers are also delivering probiotic formulations via water (Krysiak *et al*., 2021).

Gastrointestinal diseases of young animals are systemic and have a polyetiologic character. For this reason, probiotics should be considered an important part of the overall complex of therapeutic measures. Understanding the mechanism of their action and predicting the expected preventive effect allow their use in combination with other antimicrobial drugs, special feed mixtures, or compounds that suppress symptoms of diarrhea (Firkett, 2007).

Biotechnology has become increasingly important in the poultry industry, with efforts focused on creating better and more cost-effective feeds. However, proper feed utilization is crucial, as metabolic disorders can disrupt gut microflora balance and lead to digestive issues (Langhout, 2000). Therefore, a well-balanced feed ratio is essential to maintain healthy intestinal functions.

At this stage of industrial poultry production, it is essential for scientists and industry professionals to focus on the appropriate use of biologically active feed additives. These additives are important for promoting growth, enhancing development, and boosting the immune function of poultry (Izhbulatova *et al*., 2008). Probiotic supplementation in broilers can improve overall performance but has limited effects on organ weight and carcass yield. The effectiveness of probiotics is influenced by dosage, but the form of supplementation (powder vs. liquid) appears to have little impact. Future research should focus on determining the optimal dosage for broiler performance (Sjofjan *et al*., 2021).

The purpose of the conducted research is scientific substantiation of the use of the developed probiotic supplement at dry type of feeding and study of resistance and indicators of growth and development, as well as meat productivity of broiler chickens.

Among the main objectives of this study was to establish the effect and effective dose of probiotic supplements on live weight and average daily gain, stock safety and feed costs per unit of production, and dietary value of chicken meat.

Materials and Methods

The material for research were meat chickens of cross "Arbor Acres", which were raised at the poultry farm "Sary-Bulak" of Almaty region. The growing period of meat chickens was 42 days. The chickens were raised in multi-tiered cage batteries produced by "SAKO" (Italy). The number of meat chickens in each group was 100 heads. All technological parameters of microclimate in the poultry house corresponded to the recommendations on the use of probiotics in poultry farming and normative technological requirements, which were maintained in automatic mode. At the feeding of chickens of experimental groups of different-aged ("Start" and "Growth" from day old to the 28^{th} day and "Finish" from the 29^{th}-42^{nd} day of life), complete mixed fodders with the addition of different doses of the probiotic supplement were used. The chickens of the control group were fed the main diet, which included complete mixed fodders.

Nutrition, the composition of mixed fodders, and other necessary technological parameters corresponded with

the recommendations of scientists from the Kazakh National Agrarian Research University and researchers of the All-Russian Research and Technological Institute of Poultry Breeding (Fisinin *et al*., 2017; Kishnyaikina and Zhuchaev, 2017).

Economic efficiency from the use of the developed probiotic supplement was calculated according to the methodology of the All-Russian Research and Technological Institute of Poultry Breeding (Fisinin *et al*., 2013).

The obtained results were processed by methods of variation statistics described in the methodological manual of Plokhinsky N.A., as well as in the digital program Statistica 10.0 (Plokhinsky, 1978).

World experience shows that in the prevention and treatment of gastrointestinal diseases in birds, replacement therapy aimed at restoring intestinal biocenosis by regular administration of live bacteria representatives of normal intestinal microflora is of great importance.

The objects for the research were strains of lactic acid bacteria isolated from natural sources. A probiotic preparation was added when growing broiler chickens at a dose of 0.15 mL per 1 kg of mixed fodder in the first week of their growing.

Results and Discussion

The scheme of the experiment is given in Table (1). For chickens in the experimental groups, the feed additive was diluted with tap water kept for 2 days, and moistened compound feed at a rate of 50 mL of PP solution per 1 kg of compound feed. The feed additive was in liquid form so that it could be mixed relatively quickly with the ingredients of the diets. In the course of the study, the composition and nutritional value of the diets were calculated, live weight, average daily gain, feed cost per 1 kg live weight, chick safety, and nutritional quality of the meat were taken into account and economic efficiency was calculated.

Assessment of quality indicators of chicken meat for the presence of immunoglobulins, trace elements, and amino acids was carried out in the Kazakhstan-Japan Innovation Center at the Kazakh National Agrarian Research University in accordance with current state standards and using liquid chromatograph LC 20 AD, the company "Shimadzu" (Japan) and immunoanalyzer FT-2 company "AMS" (Italy).

The obtained numerical material was processed by methods of variation statistics in the Statistica 10.0 program.

The dynamics of changes in live weight of meat chickens during breeding periods are shown in Table (2).

The data show that in the first week of breeding, higher growth rates were observed in groups 2 and 3. In these groups, the live weight of chicks was higher by 5.2 and 6.3% compared to the control, while in groups 4 and 5 it was lower by 1.3 and 5.5%. In the following 3 weeks, there was a tendency to increase the live weight of chickens of the 5th experimental group, to which 0.45 mL of probiotic supplement was added to mixed fodder. The advantage in the live weight of chickens of this group in comparison with peers of control, 2, 3, and 4 groups amounted to 12.8; 6.0; 4.0, and 8.3%, respectively. At the end of the entire 42-day breeding period, the highest live weight was found in young chicks of group 5 and amounted to 2601.8 g, which was 12.8% higher than in the control ($p \leq 0.95$). It follows that for the whole period of broil-er breeding, the most effective dose of probiotic supplement should be considered 0.45 mL per 1 kg of mixed fodder. Figure (1) shows the live weight gain of broilers depending on different dosages of probiotic supplements.

Table 1: Schematic of the experiment

	Feeding schedule	
Groups	1-28 day	29-42 day
1	BR	BR
2	BR*+0.15 mL* PS* in 50 mL H_2O per 1 kg* feed	BR +0.15 mL PS in 50 mL H_2O per 1 kg feed
3	BR +0.25 mL PS in 50 mL H_2O per 1 kg feed	BR +0.25 mL PS in 50 mL H_2O per 1kg feed
4	BR +0.35 mL PS in 50 mL H_2O per 1 kg feed	BR +0.35 mL PS in 50 mL H_2O per 1kg feed
5	BR +0.45 mL PS in 50 mL H_2O per 1 kg feed	BR +0.45 mL PS in 50 mL H_2O per 1 kg feed

*BR–Basic Ration; *PS–Probiotic Supplement; *mL – Milliliter; *Kg-Kilogram

Table 2: Live weight of meat chickens during the growing period, g*

		Growing periods, weeks					
Groups	day-old chicks	1	2	3	4	5	6
1	39,9	149,2	362,3	646,0	1068,3	1901,8	2307,1
2	39,5	156,9	396,6	726,1	1141,2	1924,0	2415,3
3	39,7	158,6	394,4	720,7	1162,8	1912,5	2453,2
4	39,0	147,3	378,4	719,1	1116,3	1957,1	2503,5
5	39,3	141,0	399,5	763,1	1205,0	2081,9	2601,8

*g-Gram

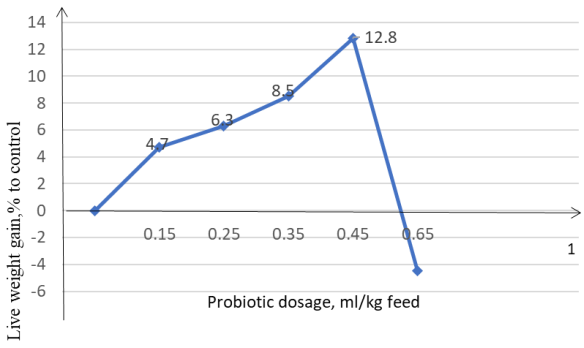

Fig. 1: Live weight gain of chickens for the whole breeding period

This tendency can be seen more clearly in Fig. (1), where the maximum live weight gain of broilers was observed in group 5, in which the dose of added probiotics was 0.45 mL per 1 kg of feed. As a side note, the point of 0.65 mL per 1 kg of feed was taken from a previously performed study in 2022. At this dose, live weight gain decreased dramatically and was associated with low feed conversion when broiler chickens were raised.

When using various biologically active feed additives in the diets of meat chickens, it is customary to take into account the indicators of average daily live weight gain, which more objectively characterize the effectiveness of their use in the feeding of young poultry. Table (3) shows calculations of the average daily live weight gains of broiler chickens.

From the data obtained, there were certain differences in the average daily weight gain of the broilers depending on the dose of the probiotic supplement and the age characteristics of the broilers. For example, in the first week of growth, the average daily gain at a dose of 0.15 mL of probiotic per 1 kg of feed was 7.7% higher than in the control group.

At doses of 0.35 and 0.45 mL, average daily gains were 1.3 and 7.1% lower than in the control group. Therefore, the 0.15 mL/kg diet dose was more effective during the first 10 days of growth in broiler chickens.

In the second and third weeks of breeding in all experimental groups, the average daily gain of meat chickens was higher than in the control group within the range of 8.5-28.1%. The highest average daily gain was observed in group 5, which exceeded the control group by 21.4 and 28.1% during the second and third weeks of breeding. During the fourth and fifth weeks of breeding at 0.15-0.35 mL/kg of feed, the average daily gains did not vary too much among themselves and were within the control group. The introduction of probiotics at a dose of 0.45 mL/kg of feed increased the average daily gain by 4.6 and 5.1%. The average daily live weight gain for 42 days of chicken breeding was: In the control group 54 g (100%), in group 2-54.8 g (101.5%), in group 3-57.5 g (106.5%), in group 4 - 58.6 g (108.5%) and in group 5-61.1 g (113.1%).

The results show that in the first 10 days of growing broiler chickens, it is more effective to use probiotics at the rate of 0.15 mL and from the second week and until the end of growing at the rate of 0.45 mL per 1 kg of mixed fodder, which allows providing an increase in the intensity of the average daily gain in live weight of young animals by 13.1%.

One of the important indicators for determining the efficiency of chicken meat production is the safety of the flock. The results for this indicator are shown in Table (4).

From the data, it is clear that the safety of chicks in the first week of breeding in all groups was absolute. In general, during the breeding period, 3 chicks were eliminated from the control group, 2 chicks each from the second and third groups, and 1 chick each from the fourth and fifth groups. Most of the chicks were eliminated due to exterior body malformations. Analyzing the obtained results, it can be noted that feeding chickens pro-biotic supplement at a dose of 0.35 and 0.45 mL/kg of mixed fodder increased the safety of livestock by 7.2% in comparison with the control group, which indicates the effectiveness of this bio supplement on the immunity of the organism of young meat birds.

After completion of rearing, the chickens were sent to the slaughter, and their carcasses were analyzed for the presence of trace elements, including selenium and iodine, in the meat. The results obtained are summarized in Table 5.

Table 3: Average daily live weight gain of meat chickens by periods of rearing, g

	Growing periods, weeks						
Groups	1	2	3	4	5	6	In a total of 42 days
1	15,6	30,4	40,5	60,3	119,1	57,9	54,0
2	16,8	34,2	47,1	59,3	111,8	70,2	54,8
3	16,7	33,7	46,6	63,2	107,1	77,2	57,5
4	15,4	33,0	48,7	56,7	119,2	78,5	58,6
5	14,5	36,9	51,9	63,1	125,2	74,3	61,1

Table 4: Safety of broiler broilers, %

	Conservation of broilers by weeks						In a total of 42 days	
Groups	1	2	3	4	5	6	of birds departed, heads	remaining, heads
1	100	93,3	90,0	90,0	90,0	90,0	3	27
2	100	96,6	93,3	93,3	93,3	93,3	2	28
3	100	100	96,6	93,3	93,3	93,3	2	28
4	100	100	96,6	96,6	96,6	96,6	1	29
5	100	100	100	96,6	96,6	96,6	1	29

Table 5: Selenium and iodine content in broiler chicken carcass meat

Groups	Carcass numbers	Selenium (Se), mg/kg*	Exceeding control (%)	Iodine (I), mg/kg	Exceeding control (%)
1k	001	0,007		0,52	
	002	0,006		0,53	
	003	0,006		0,50	
On average		0,006	0	0,52	0
4 (0.35)	010	0,037		0,93	
mL	011	0,039		0,94	
	012	0,038		0,89	
On average		0,038	633	0,92	177
5	013	0,040		1,210	
(0,45) mL	014	0,042		1,215	
	015	0,041		1,217	
On average		0,041	683	1,211	233

*mg/kg-milligrams per kilogram; k–control group

Table 6: Cost structure of growing meat chickens, Tenge

Indicators	Number of heads	Feeding period, days	Feed consumption per 1 head, kg	Feeds fed	Price *tenge	Amount, tenge
Combi-feed: «Start»	150	-	-	-	-	-
«Growth»		10	0,25	37,5	200	7500
«Finish»		18	1,1	165	180	29700
		14	1,2	180	160	28800
Total	-	-	4,85	727,5	-	-
Cost of 1 chicken	-	-	-	-	200,0	30000
Workers salaries	-	-	-	-	-	70000
Total	150	-	-	-	-	166000
Costs per chicken						1106,6

*tenge-currency of Kazakhstan

It follows from the table that selenium and iodine were present in the basic composition of mixed fodders of all variants. In this regard, it can be noted that the probiotic supplement contributed to the enrichment of chicken meat with these trace elements not only due to its composition but also due to the intensification of assimilation of these trace elements by young birds. It is known that selenium and iodine are deficient trace elements for humans, so their increased content in the meat of broilers of experimental groups makes this meat valuable for the population living in regions with low content of selenium and iodine in the environment.

The cost structure of feeding meat chickens with probiotic supplements is shown in Table (6).

The table shows that 166000 tenges were spent on growing the whole stock of chickens and 1106.6 tenges per head.

Calculations of the economic efficiency of probiotic supplement use in growing meat chickens showed that higher profitability was in the group, where probiotic was added to mixed fodder in the dose of 0.45 mL. The profit per 1 head in the control group amounted to 30 tenges and in group 5 it amounted to 45 tenges, that is, the use of probiotics increased the profit by 1.5 times.

Conclusion

1. According to the results of research, it was found that the use of all researched dosages of probiotic supplements as part of mixed fodder increases the live weight of meat chickens by the end of the growing period by 4.7-12.8% in relation to the control standard diet.
2. The optimal dose of probiotic supplement for growing young poultry for meat was established: 0.15 mL of additive per 1 kg of mixed fodder in the first week of growing, and 0.45 mL of additive per 1 kg of mixed fodder in the whole experiment. When using a dose of 0.45 ml/kg of mixed fodder, the average daily live weight gain of chickens for the whole period of growing was higher by 13.1% than in the control and the safety of livestock by 6.6%
3. The use of probiotic supplements increases the dietary value of products: in the meat of chickens of the experimental group in comparison with the control the content of selenium was higher by 6.8 times and iodine by 2.3 times.
4. As a result of research group 5 had a higher profitability of 45 tenges, compared to 30 tenges in the control group.

As a result, research into the use of biologically active feed additives to provide poultry with high-quality nutrition, increase the general and immunological resistance of the organism, increase productivity, reduce feed costs, and significantly improve the quality of products is very promising.

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Author's Contributions

Alpeisov Shokhan: Conceived the original idea, data analysis, and manuscript writing, abstract, and discussion.

Myktybayeva Raya: Reviewed and coordinated, materials and equipment engagement.

Otebayev Zhassulan: Management and manuscript are written.

Kozhakhmetova Zubaira: Designed research methodology and data in interpretation.

Boranbayeva Togzhan: Editing and literature search.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and that no ethical issues are involved.

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