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An Exploration of the Effects of Selected Growth Promoters on Broiler Chickens

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Abstract

The utilization of feed additives has experienced a notable rise, thereby playing a significant role in the accomplishments witnessed in contemporary broiler production. This study was undertaken on Ross-308 broilers that were administered probiotics (specifically Prozyme®), organic acid, a control group, and antibiotic growth boosters in order to evaluate their impact on body weight. The investigation evaluated the effects on body weight during the 1 to 35-day period. The findings suggest that the utilization of biological supplements in broiler chickens can provide notable improvements in growth performance. Among these supplements, probiotics appear to have the most favorable effects. The inclusion of probiotics in animal feed has emerged as a promising alternative to antibiotics for promoting safe broiler production. Probiotics, prebiotics, enzymes, antioxidants, acidifiers, and phytogenic additions are among the alternative growth boosters utilized in various contexts. The majority of cases have shown that these compounds have a good impact on the health and performance of broiler chickens. The utilization of alternate growth promoters in the nutritional regimen of growing chickens would result in enhanced efficiency. However, additional research is needed to understand the mechanisms by which these compounds exert their effects and how they interact with other production parameters.

Keywords: Broiler; Growth promoters; Feed; Probiotics; Body weight; Poultry

1. Introduction:

The poultry industry has emerged as a significant economic endeavor in numerous nations (Abadula et al., 2022; Attia et al., 2022). The utilization of veterinary pharmaceuticals has experienced a significant rise in recent decades as a result of efforts focused on disease prevention and control (Hampton et al., 2020). The chicken business has made significant gains in its production system over the past five decades, mostly attributed to enhancements in genetic composition, effective management practices, and advancements in the field of nutritional research (Castro et al., 2023; Himu & Raihan, 2023). The utilization of feed additives and nutritional supplements has become more significant in both the poultry industry and healthcare systems due to their diverse range of advantageous effects (Ali et al., 2021; Krysiak et al., 2021). These effects include the promotion of growth and production, enhancement of the immune system, and protection of overall health (Jha et al., 2020).

Nutritionists are consistently dedicating their endeavors to the development of enhanced and cost-effective meal options (Dunne et al., 2022). Merely having access to a sufficient food supply is not enough to achieve the desired outcome; it is equally important to effectively utilize that supply (Kittipanya-Ngam & Tan, 2020). The balance of gut microflora can be influenced by dietary changes and the absence of a nutritious diet, perhaps leading to digestive disturbances (Eltokhi et al., 2020; Shanmugam et al., 2022). The maintenance of a healthy gut also necessitates the consumption of a well-balanced diet that provides adequate energy and essential nutrients (Chatterjee et al., 2022). Nutritionists and veterinary experts have garnered significant attention in recent times due to their focus on the appropriate utilization of nutrients and the application of probiotics to enhance the growth promotion of poultry (Lambo et al., 2021; Bhogoju & Nahashon, 2022).

Feed additives are commonly regarded as substances utilized to augment the efficiency of nutrients and exert their influence on enhancing the performance of poultry (Chowdhury et al., 2023). Various feed additives are commonly employed in poultry feed, including antibiotics, probiotics, oligosaccharides, enzymes, and organic acids. Poultry and livestock diets often use these substances to enhance growth by potentially increasing feed intake (Ayalew et al., 2022; El-Hack et al., 2022). Additionally, the incorporation of minimal quantities of additives in poultry feed has the potential to enhance the yield of poultry protein intended for human consumption (Zisis et al., 2023). This, in turn, may result in a reduction in the expenses associated with animal and poultry production in certain cases (Khalid et al., 2022). There has been a notable rise in the utilization of probiotic supplementation within the realm of poultry nutrition (Jha et al., 2020; Rafiq et al., 2022). Subtherapeutic antibiotics are commonly employed for sickness prevention and facilitation of body weight augmentation (Hassan & Karslı, 2022).

The term "probiotic" refers to a live microbial feed supplement that exerts a positive impact on the host animal by enhancing its microbial intestinal equilibrium (Reuben et al., 2022). The consumption of probiotics has been shown to reduce the likelihood of developing gastrointestinal disorders through the promotion of the proliferation of advantageous microorganisms (Wang et al., 2021; Trakman et al., 2022). The administration of probiotic supplements has been found to mitigate the symptoms of lactose intolerance, improve the absorption of nutrients, and prevent or decrease the occurrence of allergies in persons who are vulnerable (Coppola et al., 2023). There have been reports indicating that probiotics possess additional properties such as antimutagenic, anticarcinogenic, hypocholesterolemic, antihypertensive, anti-osteoporosis, and immunological modulatory activities (Mondal et al., 2021; Diez-Ozaeta & Astiazaran, 2022).

The primary goal of livestock production is to achieve optimal productivity while minimizing expenses (Perakis et al., 2020; Osman et al., 2022; Raihan & Himu, 2023). The implementation of effective tactics such as proper care and feeding practices for birds, genetic structure enhancement, and the utilization of medications and similar goods to promote growth are crucial for attaining these objectives (Haque et al., 2020). Specifically, the utilization of yield-enhancing substances in the rearing of broiler chickens leads to a rapid increase in productivity, coupled with reduced consumption of feed (Wossen et al., 2023).

The present study aims to offer a comprehensive understanding of brooding management practices for broiler chickens, including their dietary program, immunization regimen, and the potential impact of growth stimulants work relevant in Bangladesh. The objective of this study was to examine the impact of probiotic and prebiotic supplementation, without feed restriction, on the performance of broiler chickens. Specifically, the study aimed to assess the impacts on body weight throughout the period from 1 to 35 days of age. Consequently, the present investigation was conducted to study the effects of probiotics (Prozyme), organic acids (PH99+), and antibiotic growth promoter (Medicalin) supplementation on growth performance in broiler chicks. Besides, this study aims to compare the growth performance of broiler chickens fed probiotics (Prozyme), organic acids (PH99+), and antibiotic growth promoters (Medicalin). The findings of the present investigation will yield a comprehensive understanding of brooding management practices for broiler chickens, encompassing their dietary regimen, immunization protocol, and the impact of growth stimulants.

2. Literature Review:

The study conducted by Barbieri et al. (2015) examined the utilization of antibiotic growth promoters (AGPs) as feed additives in intensive poultry production systems over the past five decades. These additives were employed to enhance growth, production, and feed conversion ratio by improving gut health and mitigating sub-clinical infections. However, due to apprehensions regarding antimicrobial resistance in both birds and human consumers, the use of AGPs has been largely prohibited in the majority of countries.

According to the study conducted by Li et al. (2023), there is a current utilization of nonantibiotic alternative growth promoters (NAGPs) in broiler feed as a substitute for antibiotics. These NAGPs include enzymes, probiotics, prebiotics, and acidifiers. Sodium butyrate (SB), which contains butyric acid, serves as an energy source for intestinal bacteria. Its use has been found to enhance the composition and structure of the intestinal flora, as well as improve nutrient digestibility. The enhancement of the digestive capability of the intestinal tract can be achieved by the utilization of digestive enzymes that are secreted by Bacillus subtilis (BS). The intestinal environment can be improved through the prevention of colonization by intestinal pathogenic bacteria, which can be achieved by the utilization of prebiotics primarily composed of mannose oligosaccharides (MOS). Mannanase (MAN) exhibits the capability to enzymatically break down the non-starch polysaccharide found in soya bean meal, thereby augmenting the activity of endogenous enzymes and enhancing nutrient digestibility. Due to its distinctive spatial configuration, phytase (PT) has the ability to enzymatically degrade phytic acid into inositol and inorganic phosphorus, hence facilitating the liberation of other nutrients in conjunction with phytic acid. The diverse methods and modes of action exhibited by these enzymes, probiotics, prebiotics, and organic acids indicate the possibility of complimentary synergistic benefits when incorporating a combination of these additives into dietary supplementation.

According to a study conducted by Khan and Naz (2013), it has been recognized that probiotics have the capacity to create and sustain the equilibrium of intestinal microbiota, as well as enhance the immunological capabilities and growth performances of broiler chickens. Nevertheless, there is a degree of reluctance within the poultry sector regarding the integration of probiotics into broiler diets, mostly due to the uneven outcomes observed in in vivo trials. Sugiharto et al. (2018) conducted an observation that revealed that antibiotics, despite their advantageous applications, are experiencing a decline in public perception and are causing concern due to the increasing prevalence and dissemination of antibiotic-resistant bacteria in recent times. Undoubtedly, the elimination of feed antibiotics in broiler production gives rise to specific issues pertaining to performance and health. Khan et al. (2022) have noted a growing inclination towards identifying substitutes for antibiotic growth promoters (AGPs) in poultry production systems. Consequently, there has been a quest for various classifications of feed additives for livestock animals, commonly known as natural growth promoters. These categories include probiotics, prebiotics, symbiotics, phytobiotics, feed enzymes, and acidifiers. Among these options, the incorporation of direct-fed microbials, specifically probiotics, into the diet has emerged as a viable alternative. These factors have a positive impact on the host animal by enhancing its gastrointestinal health. According to Heydarian et al. (2020), two primary mechanisms of probiotic activity are suggested. The observed effects encompass the nutritional impact of regulating metabolic reactions that generate harmful compounds and stimulating internal enzymes, as well as the production of vitamins or antimicrobial substances. It was found that broilers, when provided with a combination of Lactobacillus strains over a period of 42 days, exhibited enhancements in both body weight gain and feed conversion ratio. Hence, this study assesses the impact of Lactobacillus probiotics. Acidophilus and Bifidobacterium. The impact of Bifidobacterium bifidum on blood biochemical markers, intestinal histo-morphometry, and gut health status of broiler chickens were investigated.

In a study conducted by Mehdi et al. (2018), it was observed that poultry farmers frequently utilize antibiotic growth promoters (AGP) in order to optimize the performance and health of broiler chickens, alongside efforts to enhance feed quality. According to reports, AGP has the potential to combat pathogenic bacteria and enhance intestinal ecology and morphology, hence optimizing the processes of digestion and absorption. Additionally, AGP has the potential to optimize energy utilization for the purpose of promoting growth. Moreover, the application of AGP has the potential to enhance the environment of the digestive tract, so contributing to the preservation of chicken health.

The study conducted by Cheng et al. (2017) and Simon et al. (2021) explored the utilization of animal feed supplemented with probiotics as a feed additive for promoting growth and disease prevention. This dietary approach is not considered a new concept. Probiotics refer to living microorganisms intentionally administered to livestock in order to enhance the microbial equilibrium within the digestive tract, thereby diminishing the presence of harmful or pathogenic microorganisms such as Escherichia coli, Salmonella, and Clostridium. Additionally, probiotics exert a nutritional impact. The probiotics commonly employed in broiler chickens encompass various strains of *Lactobacillus* (*L. acidophilus*, *L. casei*, *L. farciminis*, *L. plantarum*, *L. rhamnosus*), *Bacillus* (*B. cereus var. Toyoi*, *B. licheniformis*, *B. subtilis*), *Enterococcus* (*E. faecium*), *Pediococcus* (*P. acidilactici*), *Streptococcus* (*S. infantarius*), as well as certain fungi such as *Saccharomyces* cerevisiae and *Kluyveromyces*.

According to Peng et al. (2016), the utilization of Lactobacillus plantarum showed a favorable impact on the growth of broiler chickens, resulting in a reduction in the presence of Escherichia coli in the cecum, whereas the population of lactic acid bacteria in both the cecum and ileum is enhanced. Probiotics have been documented to mitigate the adverse consequences of heat stress in broiler chickens. The study conducted by Pourakbari et al. (2016) examined the impact of probiotics on the production of broiler chickens. Probiotics have been found to contribute to enhanced body weight gain while simultaneously reducing the feed conversion ratio. The administration of probiotics was found to be responsible for the observed elevation in body weight among broiler chicks. The administration of probiotics has been shown to possess the potential to mitigate the incidence of necrotic enteritis, hence ameliorating the deleterious consequences associated with broiler chickens afflicted with Clostridium infection.

Heydarian et al. (2020) did a study investigating the utilization of antibiotics growth promoters (AGPs) in broiler diets for the purposes of disease management, health maintenance, growth stimulation, and feed utilization enhancement. Nevertheless, the utilization of antimicrobial growth promoters (AGPs) has sparked considerable concern due to the potential risks they bring to broiler and human health, specifically in terms of medicine resistance and the presence of antibiotic residues. In 2020, China implemented a prohibition on the use of AGPs, aligning itself with the European Union and the United States, which had already enacted similar measures. The implementation of regulations prohibiting the use of AGPs has compelled the industry to engage in the development of alternative antibiotics that are suitable for usage. The discontinuation of antibiotic growth promoters (AGPs) can lead to a decrease in growth rate, which can adversely affect production efficiency, food safety, and the health of broiler chickens. Consequently, in the absence of antimicrobial growth promoters (AGPs), it becomes imperative to devise alternative approaches that can effectively promote feed efficiency and maintain the health of broiler chickens.

In a study conducted by Lee et al. (2019), the researchers examined the effects of probiotics on broiler chicken health and production. Probiotics were defined as cultures of viable direct-fed microbials that enhance the immune system and competitively exclude intestinal pathogens. There have been reports indicating that the administration of probiotics can enhance the performance of chickens by promoting a stable microbial balance inside the intestinal tract, hence supporting gut integrity and reducing the occurrence of enteric illnesses. Probiotics employ three primary processes, namely competitive exclusion, bacterial antagonism, and immune system stimulation, to enhance the performance, immunity, and gut health of chickens. Probiotics have the ability to generate resistance to infections, leading to a subsequent reduction in the presence of these pathogens within the gut. This reduction ultimately contributes to an improvement in the productivity index and immune state of broiler chickens. The gastrointestinal tract (GIT) of chickens contains a wide range of microorganisms, and the interactions between these microorganisms have a substantial impact on the nutritional, immunological, and physiological well-being of the host. Therefore, the implementation of dietary modifications involving the use of feed additives presents a viable alternative that enhances the general health of the gastrointestinal tract and immune system through the promotion of specific microbial development. In this context, the incorporation of probiotics into the diet is regarded as a potentially advantageous substitute for antibiotic growth promoters (AGPs). Numerous studies have been conducted to ascertain the impact of probiotics on the growth performances and digestive health of broiler chickens. This study aimed to examine the impact of a multi-strain probiotic (MSP) consisting of *Bacillus coagulans*-Unique IS2, *Bacillus subtilis* UBBS-14, and *Saccharomyces boulardii*-Unique-28, in a ratio of 2:2:1 respectively, when used as feed additives in broiler chickens.

Furthermore, the findings of prior research conducted by Kikusato (2021), Gholami-Ahangaran et al. (2021), and Rafiq et al. (2022) have demonstrated the considerable Advantages of administering phytobiotics to broiler chickens. These benefits include the inhibition of pathogenic bacteria, enhancement of intestinal health, elevation of antioxidant levels, optimization of digestive function, and improvement of immune functions in chickens. The study conducted was to assess the impact of incorporating artichoke leaf meal and menthe extract (*Mentha piperita*) as a phytobiotic in broiler chickens. The findings indicated a reduction in concentrations of high-density lipoprotein (HDL) and low-density lipoprotein (LDL). The utilization of nutmeg flesh flour (*Myristica frangrans Houtt*) and clove leaves (*Syzygium aromaticum L*) as phytobiotics has the potential to decrease feed expenses and minimize the reliance on antibiotics in the growing process of broiler chickens. The impact of phytobiotics as feed additives on the growth performance of broiler chickens is subject to variation due to various biological factors associated with the plant, including plant species, cultivation location, harvesting conditions, as well as storage conditions encompassing light exposure, temperature, and duration of storage.

According to the findings of Ren et al. (2019), there has been a recent focus on investigating the potential of combining probiotics and phytobiotics as a substitute for antibiotics in broiler feed. The findings from in vitro studies indicate that the concurrent utilization of probiotics and phytobiotics can facilitate the proliferation of probiotic bacteria. Multiple studies have also documented that the combined administration of probiotics and phytobiotics has greater efficacy compared to their individual application. Previous research findings have demonstrated that the administration of phytobiotics, probiotics, and their synergistic combination can effectively enhance performance metrics and yield superior carcass weight outcomes. The use of a blend of phytobiotics and probiotics in the diet of broiler chickens has been shown to enhance growth performance, promote the proliferation of beneficial bacterial species, and mitigate the population of coliform bacteria. The use of a blend of *Alisma canaliculatum* and probiotics containing *Lactobacillus* species. The strain of bacteria known as acidophilus, specifically *Lactobacillus acidophilus*, is of interest in academic research. The term "plantarum, E." refers to the classification of a group of organisms known as plants. *Enterococcus faecium* with Bacillus, Bacillus subtilis *Bacillus coagulans* and *Streptococcus*. The inclusion of *Saccharomyces cerevisiae* in the diet has been shown to enhance the growth performance of broiler chickens.

Aalaei et al. (2020) discovered that the poultry production sector in India, along with numerous other countries, has had a remarkable surge in expansion, resulting in the establishment of a prominent industry. The margin of profit can be greatly enhanced by improving the feed conversion ratio (FCR), as feed alone accounts for around 70% to 75% of the overall production costs. The utilization of antibiotic growth promoters (AGP) has been extensively employed in order to augment the productivity potential of poultry and safeguard them against the threat of pathogens. There is a significant demand from consumers and producers for prospective alternatives to antibiotics, including probiotics, prebiotics, synbiotics, and postbiotics, that have been created. In contemporary times, probiotics are becoming increasingly regarded as a viable substitute, prompting numerous forward-thinking farmers worldwide to integrate them into poultry feed as a replacement for antibiotics. The utilization of probiotics is crucial for the maintenance of poultry health in large-scale production facilities. Following the prohibition of feed AGP in numerous countries, there has been a notable surge in interest among poultry producers about the use of probiotics. This heightened concern stems from the adverse effects of antibiotic usage, which include the proliferation of antibiotic-resistant microbes and the presence of antibiotic residues in animal products.

Johnson et al. (2020) undertook a study to address the existing knowledge gaps about the impact of AGP on animal performance. Understanding the physiological mechanisms is of great importance, as it has the potential to reveal biological targets that can replicate the advantages of AGP while mitigating the danger of antimicrobial resistance (AMR). Various antimicrobial agents have been employed in order to enhance weight gain and improve feed efficiency in livestock (Himu & Raihan, 2024a). The aforementioned examples encompass cyclic Peptides (such as bacitracin), ionophores (such as monensin and narasin), streptogramins (such as virginiamycin), orthosomycins (such as avilamycin), and macrolides (such as tylosin and spiramycin), among various others. Although there are variations in the antimicrobial range and antibacterial processes of these drugs, it remains uncertain whether they enhance performance through comparable or distinct mechanisms. Numerous ideas have been proposed in order to elucidate the potential impact of AGP on host physiology. However, the specific mechanisms, if any, by which AGP may exert its effects are yet inadequately characterized. Several proposed mechanisms of action for generic antibiotic growth promoters (AGPs) include the restriction of opportunistic pathogens and subclinical infections, reduction of microbial competition for host nutrients, modulation of host fat digestion and utilization, inhibition of toxin production in the gut, regulation of host immunity and inflammation, and enhancement of nitrogen balance. The significant role of the gut microbiome in the aforementioned mechanisms has led to a substantial focus on manipulating the gut microbiome to enhance the performance and health of animals as a strategy to combat antimicrobial resistance (AMR).

Die et al. (2021) suggested that organic acid may have contributed to the modifications in the intestinal microbiota, notably the enrichment of bacteria that produce short-chain fatty acids, thus, better growth performance, intestinal morphology, and barrier functions have occurred in broilers. This resulted in a more homeostatic and healthier intestinal microecology. Bagal et al. (2016) studied and established that, in comparison to the antibiotic-supplemented group, the growth performance of the birds improved significantly in the 1% citric acid group in terms of body weight, body weight gain, and FCR. Chlortetracycline, an antibiotic growth stimulant, can be successfully substituted with 1% citric acid without impairing bird growth.

According to Vinus et al. (2017), the microbial equilibrium in the gastrointestinal system can be maintained by inhibiting microbial growth in meals with the use of organic acids and salts. The morphology of the intestinal wall may be significantly impacted by changes to the gut microbiota that lessen pathogen adhesion. One such SCFA that exhibits increased bactericidal action when the acid is undissociated is butyric acid. Additionally, butyrate seems to be involved in the formation of the intestinal epithelium. On the other hand, young chicks may be the greatest candidates for food supplementation because their intestinal and caeca have relatively low quantities of SCFA. Saleh et al. (2022) discovered that growth in broilers was improved when humic acid (HA) and lincomycin were included in the diet. After 35 days, body weight rose but feed intake decreased; as a result, feed conversion ratio was improved by HA and lincomycin supplementation. Crude protein retention was enhanced by lincomycin and HA supplementation. Additionally, these additions, especially at higher HA/lincomycin concentrations, lengthened intestinal villi and decreased degenerative changes in the gut, which lessened the negative effects of clostridial infection.

Elkomy et al. (2019) showed a significant increase in body weight, weight gain, phagocytic activity, phagocytic index, erythrocytic count, hemoglobin level, packed cell volume, total leukocytic count, serum total protein, albumin, total globulin, α, β, and γ globulin in broiler chicks given bacitracin, lincomycin, or both. In addition, compared to the control group, there was a notable increase in malondialdehyde and a substantial drop in catalase and superoxide dismutase, as well as a marked decrease in blood total lipid, cholesterol, and triglycerides and albumin-globulin ratio. In conclusion, the growth performance, immunological, and hematobiochemical parameters of broiler chickens are positively impacted by bacitracin and lincomycin, either separately or in combination. Therefore, it is advised to use both medications to encourage growth in broiler chickens. Rasool et al. (2017) studied that in their local environment, niacin and levofloxacin together have a negligible positive impact on broiler growth when compared to other groups.

3. Materials and Methods:

3.1. Study area, population and period

The research was conducted at Narikelbaria Veterinary Clinic, University of Rajshahi, Rajshahi District of Bangladesh (Figure 1). The current study was conducted on a cohort of 40-day-old Ross 308 broiler chicks from Nahar Agro. The investigation was carried out over the 5-week period spanning from August to October 2023. The laboratory experiments were conducted in the Department of Veterinary and Animal Sciences, Faculty of Veterinary and Animal Sciences, University of Rajshahi, Rajshahi, Bangladesh.

Figure 1: Map of study area of Rajshahi District, Bangladesh

3.2. Experimental design:

The procurement of 40 newly hatched Ross 308 broiler chicks was made from Nahar Agro hatchery. The subjects were initially raised for a period of seven days in a designated brooding facility, during which they were provided with consistent feed drinking water, and growth promoter supplementation to facilitate acclimatization. Subsequently, the avian specimens were relocated to the designated experimental facility and subsequently segregated into distinct cohorts, each subjected to varying treatment protocols (Table 1, Figure 2). The floor of each enclosure was covered with sun-dried rice husk litter materials, with a depth of around 3cm.

Treatment	Trade name	Components	Company	Dosage	Number of birds treated
T1	PH_{99+}	Citric Acid-120g, Formic Acid-40g, Butyric Acid- 40g, Lactic Acid-30g, Propionic Acid 229g, Acetic Acid- 10g, Malic Acid- 5g, Sorbic acid-2g, Solvents up to 1 l	G FIVE Animal Science Ltd	1ml/2l DW	10
T2	MEDICALIN 4.4%	Lincomycin 44mg/g	Medicavet Animal Health	1g/1l DW	10
T3	Prozyme	Cellulase (min) 1000000 IU/KG Xylanase (min) 1000000 IU/KG Beta-glucanase (min) 500000IU/KG Alpha-amylase (min) 1500000IU/KG Protease (min) 10000IU/KG Phytase (min) 25000iu/kg *Bacillus subtilis* 1108CPU/KG *Bacillus licheniformis* (min)110 8CPU/KG *Lactobacillus acidophilus* (min) 1104CPU/KG *Lactobacillus plantarum* (min) 110 4CPU/KG Moisture (max)-10%	G FIVE Animal Science Ltd	1g/2l DW	10
T4	Clean drinking water				10

Table 1: Treatment protocols

Figure 2: Growth promoters used in the study

Figure 3: Bird management (Source: Author)

3.3. Bird management

The broiler birds were placed in distinct enclosures, and their respective weights were measured initially (Figure 3). A one-week adjustment interval was provided to facilitate the birds in eliminating previously consumed feed and adapting to both the feed and the surrounding habitat. Following a time of adjustment, the experiment was subsequently resumed. Stringent aseptic measures, such as the implementation of disinfection protocols for hand and foot hygiene upon entry, were also enforced.

3.4. Broiler feed formulation

An illustrative instance of a broiler feed composition is presented in Table 2.

Feed Ingredients	Broiler Starter Feed	Broiler Grower Feed	Broiler Finisher Feed
Corn (kg)	55	44	60
Soybean meal (kg)	35	35	25
Rice polish (kg)	13	12	12
Fish meal analog (kg)	7	6	4
Soybean oil (kg)	-	1	-
Limestone (kg)	2	2	2
Table salt	0.1	0.1	0.3
DCP (kg)	0.5	0.5	0.5
Vitamin & Mineral Premix	0.5	0.5	0.3
L-Lysine (kg)	0.15	0.15	0.15
DL-Methionine (kg)	0.1	0.1	0.15
Toxin binder	0.15	0.15	0.15
Mold Inhibitors (kg)	0.1	0.1	0.1
Salmonella killer	0.05	0.05	0.05
Anti-coccidial (kg)	0.05	0.05	0.05
Multi-Enzyme with phytate	0.05	0.05	0.05
Sodium Bicarbonate (kg)	-	0.1	0.1
Antioxidant	0.01	0.1	0.01
Total	104.21		101

Table 2: An illustrative instance of a broiler feed composition

The feed consumption rate is a crucial aspect of broiler feed formulation. The information provided in Table 3 serves as a reference point, however, it is important to note that many factors such as broiler breeds, parents, management practices, and feeding techniques employed on the farm may lead to potential modifications.

Age (week)	Feed consumed per broiler (kg)	Cumulative feed consumed (kg)	Average body weight per broiler (kg)
1	0.133	0.133	0.14
2	0.282	0.415	0.36
3	0.466	0.88	0.65
4	0.673	1.55	1.02
5	0.849	2.40	1.46
6	1.071	3.47	1.91
7	1.181	4.65	2.36
8	1.3	5.95	2.79
9	1.41	7.36	3.19

Table 3: The feed consumption rate in broiler feed formulation

3.5. Experimental procedures

3.5.1. Body weight gain and feed intake

The experiment involved the recording of body weight gain (BWG) and feed intake (FI) of chicks on the 21st and 35th day. The initial body weights of the groups were comparable before the allocation of diets, with an average of 41g per bird. Figure 4 presents the vaccination program for broilers.

Figure 4: Successful vaccination program for broilers (Source: Author)

3.5.2. Feed conversion ratio

The chicks underwent daily inspections, during which any deceased birds were promptly removed and recorded with the corresponding date and body weight. The Feed Conversion Ratio (FCR) was determined by dividing the Body Weight Gain (BWG) in grams by the Feed Intake (FI) in grams. In the computation of FCR, the body weights of deceased avian specimens were also taken into account.

3.5.3. Statistical analysis

Data used the analysis of variance (ANOVA) and the difference between treatment means was compared using Duncan's new multiple range test according to Steel and Torrie (1992) by R program version 3.5.1 (R core team, 2018), which was significant at $P<0.05$ and $P<0.01$.

4. Results:

4.1. Body weight gain and feed intake

The effects of organic acid, prozyme, and antibiotics on body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR), protein intake (PI), and protein efficiency ratio (PER) are shown in Table 4. Prozyme resulted in a significant ($p<0.05$) increase in BWG during the starter and from 0-35 days of age compared to the control and other diets. Figure 5 presents the body weight of birds in four different time periods.

	Dietary treatments	0-21 day	22-35day	22-35day
Body weight gain (BWG)	Control	612.01±13.47 ^{b}	1659.92±25.21	2273.24 ±39.40 ^{b}
	Medicalin	668.94±15.29 ^{a}	1731.85±46.51	2400.79±45.45 ^{a}
	Prozyme	638.73±25.94 ^{ab}	1700.44±30.44	2339.16±37.17 ^{ab}
	PH_{99+}	621.83±1.89 ^{ab}	1662.37±13.96	2284.20±15.45 ^{b}
Feed intake (FI)	Control	1024.98±6.50	3836.3±158.18 ^{a}	4861.3±163.55
	Medicalin	1024.53±22.47	3486.5±70.56 ^{b}	4511.0±85.41
	Prozyme	986.00±33.83	3748.9±115.49 ^{ab}	4734.9±108.82
	PH_{99+}	1025.57±24.50	3659.9±55.86 ^{ab}	4685.5±70.01
Feed conversion ratio (FCR)	Control	1.67830±0.04 ^{a}	2.3568±0.13 ^{a}	2.17502±0.10 ^{a}
	Medicalin	1.53177±0.00 ^{b}	2.0172±0.05 ^{b}	1.88015±0.03 ^{b}
	Prozyme	1.54669±0.03 ^{b}	2.2116±0.10 ^{ab}	2.02751±0.06 ^{ab}
	PH_{99+}	1.64945±0.04 ^{a}	2.2019±0.03 ^{ab}	2.05135±0.02 ^{ab}
Protein intake (PI)	Control	209.147±1.32	782.81±32.27 ^{a}	991.95±33.37
	Medicalin	209.056±4.58	711.42±14.39 ^{b}	920.47±17.42
	Prozyme	201.192±6.90	764.96±23.56 ^{ab}	966.16±22.20
	PH_{99+}	209.268±5.00	746.81±11.40 ^{ab}	956.08±14.28
Protein efficiency ratio (PER)	Control	2.92744±0.07 ^{b}	2.0984±0.11 ^{b}	2.26941±0.10 ^{b}
	Medicalin	3.19962±0.01 ^{a}	2.4362±0.06 ^{a}	2.60995±0.04 ^{a}
	Prozyme	3.17391±0.06 ^{a}	2.2344±0.09 ^{ab}	2.42740±0.07 ^{ab}
	PH_{99+}	2.97846±0.07 ^{b}	2.2276±0.03 ^{ab}	2.39096±0.03 ^{b}

^{a,b} means (±SEM) in the same row with no common superscript differ significantly ($p<0.05$)

Table 4: Effect of dietary Medicalin, Prozyme, and PH_{99+} on the performance of the broiler chicks

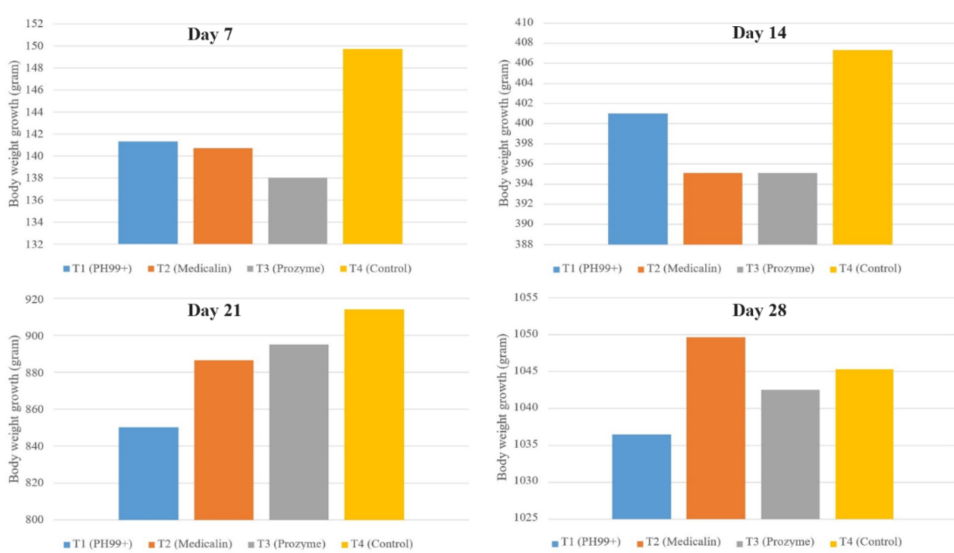

Figure 5: Body weight of birds (Source: Author's own calculation)

During the concluding phase of the trial, there was no statistically significant difference ($p>0.05$) observed in BWG across the various groups. The birds who were provided with the control diet exhibited a statistically significant increase ($p<0.05$) in feed intake (FI) during the finisher period compared to the birds that were fed the Prozyme diet. In general, the findings indicate that the birds that were provided with supplementary growth boosters exhibited somewhat more body weight gain (BWG) compared to those on the control diet.

The observed correlation between Medicalin and body weight gain (BWG) exclusively during the initial phase can perhaps be attributed to the proposed theory. It is important to note that the control diet exhibited a considerably greater food intake (FI) compared to the organic acid diet during the evaluation of palatability in acidified diets. This difference is attributed to the fact that acidifiers have a low propensity to release their H+ ions, resulting in a distinct flavor that may be perceived as strong. Figure 6 presents taking body weight of broiler chicks and Figure 7 presents the feed intake of broiler chicks.

Figure 6: Taking body weight of broiler chicks (Source: Author)

Figure 7: Feed intake of broiler chicks (Source: Author)

4.2 Feed conversion ratio:

During the initial phase, it was seen that birds who were provided with supplementary Medicalin and Prozyme exhibited considerably enhanced feed conversion ratio (FCR) in comparison to those on the control diet, with statistical significance at a p-value of less than 0.05. However, it should be noted that FCR improvements, at a p-value of less than 0.05, were only shown during the finisher phase and from 0-35 periods in chicks that were fed a diet containing Medicalin, while no significant improvements were observed in the other diets. No significant difference was observed during the entire duration between the birds that were fed a control meal and those that were provided with food supplemented with a PH99+. The improved feed conversion rate (FCR) observed in these diets may be attributed to factors such as increased body weight gain, reduced feed consumption, and potential enhancements in intestinal conditions that promote enhanced digestion, absorption, and more efficient utilization of nutrients. The findings of the FCR acquired in this experiment validate.

5. Discussion:

Based on the findings of this experiment, it was seen that the administration of Prozyme supplements in isolation yielded the most favorable weight gain outcomes, exhibiting a lower feed conversion ratio compared to all other types of supplements after the conclusion of the experimental period. This finding is consistent with the study conducted by Popova (2017), Kazemi et al. (2019), Ramlucken et al. (2020), and Keerqin et al. (2021), which reported that birds fed with probiotics exhibited a greater increase in body weight. The potential cause of the observed weight gain could be attributed to the stimulatory impact of probiotics on factors such as digestibility, feed consumption, and the modulation of gut microbiota (Jha et al., 2020). The observed acceleration in body weight gains within both groups supplemented with probiotics can potentially be attributed to heightened levels of feed intake, feed consumption, nutrient utilization, digestion, absorption, and metabolic processes. These factors are crucial for promoting overall health and facilitating weight development in the subjects.

Furthermore, within the scope of the current investigation, it was discovered that the administration of Prozyme exerted a noteworthy impact on growth performance, carcass yield, and dressing percentage subsequent to a treatment period of 35 days. This finding suggests an enhancement in the gastrointestinal well-being of broiler chickens. Hence, it can be inferred that Prozyme has the potential to serve as a viable alternative to antibiotics as growth promoters in the broiler business, thereby contributing to the preservation of food safety. However, future research should be conducted on the dose-dependent effects of probiotics and organic acids, with a larger sample size of birds at the farm level. Additionally, molecular investigations should be conducted to enhance our understanding in this area.

In recent decades, the implementation of various advancements in poultry and livestock farming has led to significant improvements in productivity (Bhogoju & Nahashon, 2022; Raihan, 2023; Himu & Raihan, 2024b). These advancements include the adoption of high-growth and reproductive genetic selection, the utilization of innovative husbandry practices such as hygiene, vaccination, shelter, and mobility, as well as a deeper understanding of the digestive physiology and dietary needs of farm animals (Hafez & Attia, 2020; Rahman et al., 2022). The discovery that the administration of sub-therapeutic doses of antibiotics in animal feed can have a substantial impact on promoting growth represents a notable advancement in the field of poultry and cattle production (Low et al., 2021; Rahman et al., 2022; Kariuki et al., 2023).

In the field of human medicine, the concept of health is frequently associated with the state of being free from clinical disease. Nevertheless, the application of this definition to livestock is limited, as it is widely acknowledged that the well-being and productivity of farm animals can be negatively impacted even in the absence of observable symptoms of illness (Cobo-Angel et al., 2021; Windsor, 2022). The aforementioned discrepancy likely served as a catalyst for agricultural establishments to explore the utilization of sub-therapeutic dosages of antibiotics in the feed of farm animals, with the intention of both illness prevention and promotion of growth (Gadde and Kim, 2017; Masud et al., 2020). Various mechanisms are implicated in the regulation of animal health and growth via the administration of antibiotics, with certain pathways still little comprehended (Lillehoj et al., 2018). Although there have been documented physiological (related to digestion and absorption), nutritional (pertaining to diet), metabolic, and immunological responses to the administration of feed-grade antibiotics, the prevailing outcome indicates that their utilization enhances feed efficiency and promotes accelerated growth, even when feed intake is constant (Lillehoj et al., 2018; Corsello et al., 2020).

In aggregate, there is currently a diverse array of products and novel formulations being researched and created with the aim of substituting antibiotics as growth promoters in poultry feed regimens (Manzoor et al., 2022). The continuous pursuit of more practical and environmentally friendly alternatives is anticipated to expand the range of target functions that will undergo more investigation (Raihan et al., 2022; 2023). Although there is currently no option that can completely replace antibiotics in animal feed, there are various alternatives that hold significant value and can be used in practical poultry production systems aiming towards antibiotic-free practices (Abreu et al., 2023). Although certain alternatives to antibiotics have demonstrated efficacy in promoting animal growth and maintaining their health, the primary concerns associated with these alternatives are their reliability, species-specific variations, economic implications, and manufacturing complexities (Ndomou & Kemp, 2021). For instance, because of variations in intestinal physiology and microbiota among different animal breeds, the efficacy of an alternate approach may differ between breeds (Schmiedová et al., 2022). Ensuring an appropriate alternative dosage within the feed-in function for various animal breeds and species is crucial for achieving optimal outcomes and mitigating potential adverse effects (El-Hack et al., 2022).

The process of introducing a novel substitute for antibiotic growth promoters into the market necessitates the evaluation of its safety for several stakeholders, including the animal, consumer, user, and environment (Ashraf et al., 2021). Additionally, the assessment must consider the effectiveness, acceptability, and practicality of the alternative. Ultimately, the effective commercialization of a particular option is contingent upon a range of criteria. Important variables include overall costs and advantages, regulatory permission, and target animals. The process of regulatory approval exhibits variation across different countries, yet the fundamental analysis method stays consistent. Consequently, these alternatives require thorough evaluation and analysis. The pace of technological advancements is rapid, encompassing a diverse array of items that may not conform to the conventional definition of a veterinary medical product or neatly align with established product classifications. Consequently, there is a need for a clear understanding of the regulatory framework and criteria that should be employed to govern these innovations.

6. Conclusions:

The main objective of this research endeavor was to investigate the effects of probiotic and prebiotic supplementation, on the performance outcomes of broiler chickens. This study evaluated the effects on body weight, carcass characteristics, and feed production costs during the 1 to 35-day period. The findings suggest that the utilization of biological supplements in broiler chickens can provide notable improvements in growth performance. Among these supplements, probiotics appear to have the most favorable effects. The inclusion of probiotics in animal feed has emerged as a promising alternative to antibiotics for promoting safe broiler production. The removal of antibiotics from poultry feed has necessitated the exploration of other strategies that can enhance the health and productivity characteristics of broiler chickens. Probiotics, prebiotics, enzymes, antioxidants, acidifiers, and phytogenic additions are among the alternative growth boosters utilized in various contexts. The majority of cases have shown that these compounds have a good impact on the health and performance of broiler chickens. However, additional research is needed to understand the mechanisms by which these compounds exert their effects and how they interact with other production parameters. The utilization of alternate growth promoters in the nutritional regimen of growing chickens would result in enhanced efficiency. The utilization of antibiotic growth promoters (AGPs) is not the sole determinant impacting the efficacy of broiler farming enterprises. The current study's results provide a full comprehension of brooding management strategies for broiler chickens, including their food regimen, immunization routine, and the effects of growth stimulants.

Author Contributions:
Conceptualization, M.I.Z.M.; methodology, M.I.Z.M. and H.A.H.; software, M.I.Z.M., A.R. and H.A.H.; validation M.I.Z.M.; writing—original draft preparation, M.I.Z.M. and H.A.H.; writing—review and editing, A.R.; visualization, M.I.Z.M., A.R. and H.A.H.; supervision, M.I.Z.M. All authors have read and agreed to the published version of the manuscript.

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