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Animal Health and Well Being

Data analytics-based evaluation of blood indices and adaptation of medicated and non-medicated broiler chickens under humid tropical conditions

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Abstract

The growth performance and blood indices of medicated and non-medicated broiler chickens have been the subject of this research coupled with a paucity of comparative information on what can actually happen to broiler chickens if not medicated when reared under humid tropical conditions. One hundred unsexed day-old broilers were randomly and equally allotted into two treatment groups of TM (medicated) and TN (non-medicated) in a completely randomized design each treatment with five replicates having ten birds each. The birds were reared on deep litter system for 56 d which was divided into two phases of 28 d each (starter and finisher), during which data were collected with respect to daily feed intake, final body weight, body weight gained (BWG), mortality rate while blood analysis was carried out on 28th and 56th d for starter and finisher phases, respectively. Non-medicated group served as control. Feed conversion ratio (FCR) and feed conversion efficiency (FCE), were later calculated. Data collected were subjected to analysis of variance statistically. There was no significant difference between the medicated and non-medicated broilers for daily feed intake, final body weight, and BWG and also for the blood parameters investigated at starter phase. However, at finisher phase, no significant difference was observed in the daily feed intake of Tm and Tn but there was significant ($P < 0.05$) difference in the final body weight, BWG, FCR, FCE, and mortality rate between the two groups. Birds on Tm attained higher weight significantly ($P < 0.05$) than those on TN. BWG, FCR, and FCE followed the same trend and also the mortality rate. White blood cells count of TN was higher significantly ($P < 0.05$) than TM while TM birds recorded higher packed cell volume, red blood counts, and hemoglobin concentration (Hb) significantly ($P < 0.05$) than TM birds. Effect of medication was much noticeable at finisher phase as it improved the growth rate though mortality rate was close to that of TN group. These results suggest that broilers can be produced free of medication with good feeding without loss of birds while the growth rate can be enhanced with the use of prebiotics and prebiotics.

Lay Summary

Medication is being used to manage poultry diseases globally. With the advent of organic farming to circumvent the side effects of the continuous use of drugs, there is need to establish the extent to which broiler chickens can be raised without medication in humid tropical conditions. Two treatment groups were arranged into one hundred unsexed day-old broilers were randomly divided. The first group was tagged Tm (medicated) and Tn (non-medicated) in a completely randomized design. Each treatment group had five replicates with ten birds. They were reared for 8 wk in two phases of 4 wk each (starter and finisher), during which data were collected with respect to daily feed intake, final body weight, body weight gained, and mortality rate while blood analysis was carried out on the 28th and 56th d for starter and finisher phases, respectively. The non-medicated group served as control. Feed conversion ratio and Feed conversion efficiency were later calculated. Data collected were analyzed statistically. There was no difference between the medicated and non-medicated broilers for the performance indicators and blood indices measured at the starter phase but at the finisher phase, significant differences were noted in the daily feed intake, final body weight, and weight gained among the two groups of the chickens with medicated group having better results. The same trend was observed for the blood indices. These results suggest that broilers can be produced free of medication with the provision of good-quality feed at all times.

Key words: broilers, health, immunity, medication, performance

Introduction

The growth performance and blood indices of broiler chickens are crucial factors that determine the profitability and sustainability of poultry farming (Alabi et al., 2015).

The use of medications in poultry farming has been widely adopted to prevent and treat diseases, as well as to enhance growth and feed efficiency. However, the impact of medications on the growth performance and blood indices of broiler chickens is still a matter of debate in this era of organic farming (Diarra and Malouin, 2014, Karin et al., 2018; Zain et al., 2023).

Growth performance is a critical parameter in broiler production as it affects feed intake, feed conversion ratio (FCR), and body weight gain. Medications are often used

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to promote growth and improve feed efficiency in broilers. However, studies have reported conflicting results regarding the effects of medication on growth performance. For instance, a study conducted by Islam et al. (2022) reported that the use of antibiotics significantly improved body weight gain and feed efficiency in broiler chickens. In contrast, a study by Hamid et al. (2019) found that the use of a growth promoter did not significantly affect the growth performance of broiler chickens. These conflicting results may be attributed to differences in the types of medications used, dosage, and duration of administration, as well as variations in management practices and environmental conditions.

Markovi et al. (2009) compared the growth performance of medicated and non-medicated broilers and found that medicated birds exhibited higher body weight and improved FCR, compared to their non-medicated counterparts. Similarly, Carvalho and Santos (2016) reported increased feed intake and improved weight gain in medicated broilers compared to non-medicated ones. These findings suggest that certain medications can enhance growth performance in broilers, leading to improved productivity.

The use of medications such as antibiotics and coccidiostats have been banned in some countries (Gaucher et al., 2015) because of some disadvantages such as antibiotic resistance (Dibner and Richards, 2005). Over time, bacteria can evolve and become resistant to the antibiotics used, rendering them ineffective in treating both poultry and human infections. This resistance can then spread from the farm to the surrounding environment and ultimately affect human health when people come into contact with the resistant bacteria. (Aarestrup et al., 2000, 2001; Luangtongkum et al., 2007; Folster et al., 2012). Also, there can be transfer of antibiotic residues. Antibiotics administered to poultry can leave residues in the meat and eggs. If not carefully managed, these residues can end up in the food supply and pose a risk to consumers (Bacanlı and Başaran, 2019). Ingestion of antibiotic residues can contribute to the development of antibiotic resistance in humans and may also lead to allergic reactions or other adverse health effects (Moreno-Bondi et al., 2009; Derakhshan et al., 2018; Mohammed et al., 2022). Moreover, antibiotics do not discriminate between harmful and beneficial bacteria in the bird's gut. This can disrupt the natural balance of gut microbiota, which plays a crucial role in digestion, nutrient absorption, and overall bird health. Disruptions to gut microbiota can lead to digestive issues and other health problems in poultry (Hussein et al., 2020). Antibiotics used in poultry production can leach into the soil and water through runoff from farms. This contributes to the accumulation of antibiotics in the environment, potentially impacting wildlife and aquatic ecosystems. It also promotes the development of antibiotic-resistant bacteria in the environment, further exacerbating the global antibiotic resistance crisis (Craven et al., 2001). As antibiotic resistance spreads from animals to humans, it becomes increasingly challenging to treat bacterial infections in people. Medications that were once effective may no longer work, leading to prolonged illnesses, increased healthcare costs, and higher mortality rates from previously treatable infections (Lee et al., 2011). Concerns about the use of antibiotics in poultry production have led to increased consumer awareness and demand for antibiotic-free or reduced-antibiotic products. This has put pressure on the poultry industry to adopt more sustainable and responsible practices, which can be challenging and costly to implement (Skinner et al., 2010).

Lillehoj and Lee (2012), outlined other alternatives to the use of medication in broilers production such as innate immunity of the birds, use of plants-derived phytochemicals (phytobiotics and phytogenics) can be well used to improve growth rate and gut microflora of the chickens. Herbs and spices such as coricander, cinnamon, black cumin, green tea, ginger, garlic, pepper, and thyme have been used as organic growth enhancers, antioxidants, and immune boosters in ruminant and non-ruminant animal production (Adeniyi et al., 2011; Lee et al., 2013; Alabi et al., 2017; Ayoola et al., 2023).

Similarly, as concerns about antibiotic resistance and the potential drawbacks of using antibiotics in poultry production have grown, the search for viable alternatives has intensified. Several alternative strategies and practices have been developed to promote poultry health without relying on medications. Vaccinating poultry against specific diseases is a highly effective way to prevent infections and reduce the need for antibiotics. By administering vaccines, farmers can build immunity in their flocks and protect them from various bacterial and viral diseases (Karin et al., 2018). Implementing strict biosecurity protocols can help prevent the introduction and spread of pathogens on poultry farms. This includes controlling farm access, limiting contact with wild birds, proper waste disposal, and maintaining hygienic conditions in poultry houses (Persoons et al., 2012; Gelaude et al., 2014; Postma et al., 2016; Caekebeke et al., 2020). Furthermore, probiotics are beneficial live microorganisms that can be administered to poultry to support gut health and improve digestion. Prebiotics, on the other hand, are non-digestible food components that promote the growth of beneficial gut bacteria. Both probiotics and prebiotics can help maintain a healthy gut microbiome and enhance the bird's natural defense against pathogens and are much more beneficial and safer in use than drugs (Al-Khalaifah, 2018; Christy et al., 2018; Hakimul et al., 2020; Letlhogonolo et al., 2020; Ayalew et al., 2022).

Organic acids and essential oils have shown promise in reducing the growth of harmful bacteria in poultry and improving overall gut health. These natural compounds can act as alternatives to antibiotics in controlling bacterial infections.

The aim of this experiment was to compare some performance characteristics and blood parameters of medicated and non-medicated broiler chickens at both starter and finisher phases in a typical humid tropical environment. This is highly essential in line with clamor for organic products which are getting awareness in developing countries now.

Materials and Methods

The study aimed to evaluate the growth performance and blood indices of medicated and non-medicated broiler chickens. A randomized controlled trial was conducted, following ethical guidelines for animal research as stipulated in the ethical codes of the University with approval granted to conduct this experiment. A total of 100 unsexed d-old Abor acre broilers were obtained from a commercial hatchery and randomly allocated into two groups: a medicated group (TM) and a non-medicated group (TN). Each group consisted of 50 birds. The medicated group received the prescribed set of medications prophylactically (preventive) and therapeutically (treatment) in response to manifested symptoms. They were given broad-spectrum antibiotics from days 1 to 7, coccidiostat from days 15 to 22, and anti-chronic respiratory disease drugs from days 35 to 42. Oxytetracyline-based antibiotics, tylosin-based antibiotics, and sulphadimidine-based cocciostat were used. The medications were administered orally via drinking water at the recommended dosage throughout the study period. The non-medicated group served as the control and received a standard non-medicated regime. The experimental birds were raised on deep litter of wood shavings. Space allowance per bird is 0.75 $m^{2.}$ The depth of the litter material above the floor was 4.0 cm. The experiment lasted for 56 d but in two equal phases (starter and finisher) during which data were collected in respect of daily feed intake, weekly body weight of individual birds, weekly body weight gain. FCR was calculated as the ratio of feed intake to body weight gain and the feed conversion efficiency was calculated as the reciprocal of the FCR. Both calculations were done at the end of each phase (starter and finisher). The birds were fed a standard commercial diet formulated to meet the nutrient requirements of broiler chickens (Table 1). The medicated group was fed the same diet as the non-medicated group. The birds were fed ad libitum with broiler starter mash in the first phase and broiler finisher mash in the second phase and water was provided ad libitum as well. Blood collection was done on 28th and 56th d of the experiment. Blood samples were collected from the wing web vein of 30 birds per group into bottles containing anticoagulant (ethylene-diamine-tetra-acetic acid; EDTA). Blood parameters investigated are packed cell volume, Hemoglobin concentration (Hb), red blood cell count (red blood counts), white blood cell count (WBC) using the procedures earlier described by Briggs and Bain (2012), while mean cell volume, mean cell hemoglobin, mean cell hemoglobin concentration were calculated as follow using the formulae reported by Briggs and Bain (2012);

$$MCV = PCV \div RBC$$

$$MCH = (Hb \div RBC) * 10$$

$$MCHC = (Hb \div PCV) * 100$$

All data were analyzed by 1-way ANOVA using Statistical Analysis Systems (SAS) statistical software package (Version 9.2, SAS Institute, Cary, NC, USA), and means were compared by Duncan's multiple comparison tests, considered significantly different at $P < 0.05$.

Results and Discussion

Table 1 and Figures 1 and 2 show the gross composition of the feed-fed experimental birds at the starter and the finisher phases. The metabolizable energy and crude protein content of the starter and finisher mash are consistent with the recommended levels for broilers during these respective phases. The values were within the range earlier recommended by Olomu and Offiong (1980) and Ahiwe et al. (2019).

Table 2 and Figure 3 show the effect of medication on some performance characteristics of broiler chickens at starter phase. No significant ($P > 0.05$) difference was observed in the mean values for initial body weight, final body weight, feed intake, FCR, and feed conversion efficiency between the birds in medicated and non-medicated groups. This is in agreement with the earlier findings of Giambrone (1981) and Su et al. (2020) that the effect of medication on broilers are majorly tangible during the finisher phase as the immune system of the birds are rather high at starter phase to suppress any antigenic challenge.

Table 3 shows the effect of medication on hematological parameters of broiler chickens at starter phase while Table 4 shows the effect of medication on performance characteristics of broilers at finisher phase. The medicated

Table 1. Gross composition of diets fed at starter and finisher phases

Ingredients	Broiler starter diet, %	Broiler finisher diet, %
Maize	55.00	60.00
Wheat offal	10.48	10.50
Fish meal	6.00	5.00
Soybean meal	24.00	20.00
Oyster shell	3.00	1.00
Bone meal	3.00	4.00
Broiler premix*	0.25	0.25
Salt	0.25	0.25
Lysine	0.10	0.10
Methionine	0.10	0.10
Total	100.00	100.00
Calculated values		
Metabolizable energy, $Kcalkg^{-1}$	2,786.90	2,835.18
Crude protein, %	22.20	20.18
Crude fibre, %	4.32	5.05
Calcium, %	1.05	1.01
Phosphorus, %	0.46	0.42
Lysine, %	1.10	1.05
Methionine, %	0.42	0.40

*Premix to provide the following per kg of meal: Vitamin A—10,000 iu; Vitamin D3—1,500 iu; Vitamin E—3 iu; Vitamin k3—2 mg, Riboflavin—25 mg; Nicotinic acid—12 mg; Chlorine – 900mg; Folic acid—1.7 mg; Biotin—1.6 mg; Copper—2.5 mg; Zinc—5 mg; Cobalt—1.0 mg; Selenium—0.15 mg; Panthothenic acid—7 mg; Cobalamin—0.90 m; and Manganese—80 mg.

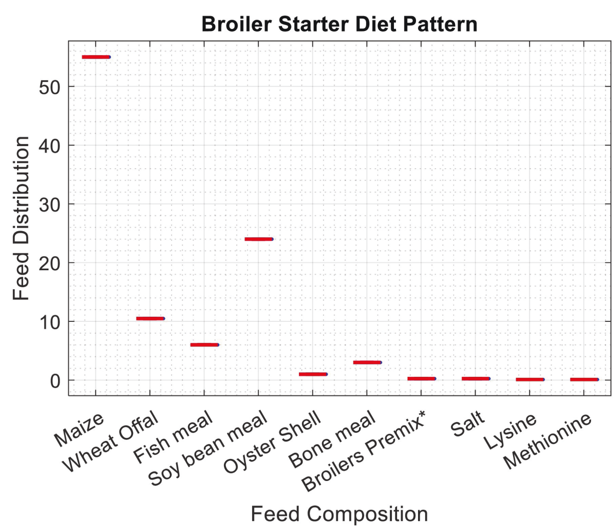

Figure 1. Gross composition of feed given to the broilers at starter phase.

group ate more and grew better significantly with lesser mortality rate than the non-medicated group of broilers. These findings are consistent with previous studies (Enberg et al., 2000; Baurhoo et al.,2009; Mehdi et al., 2018) which reported that medicated broilers exhibited higher body weight gain and improved FCR compared to non-medicated birds. Surprisingly, birds in non-medicated group ate as closely as their medicated counterpart but the conversion ratio was higher with poor feed efficiency. The improved growth performance in the medicated group can be attributed to the positive influence of medication on nutrient utilization, metabolism, and overall health of

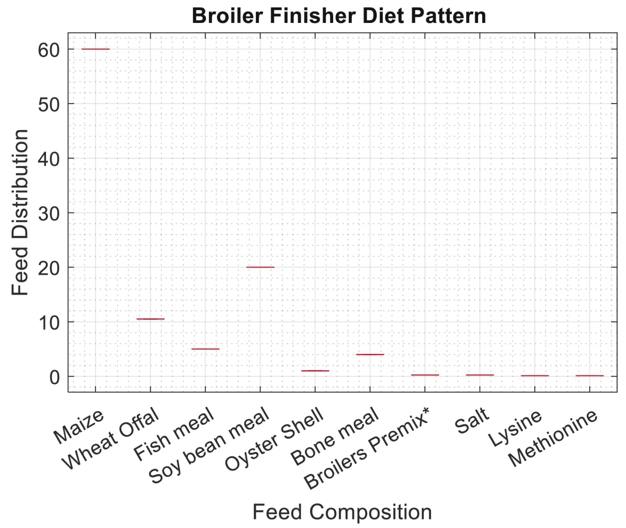

Figure 2. Gross composition of feed given to the broilers at finisher phase.

Table 2. Effect of medication on performance characteristics of broiler chickens at starter phase

Parameters	TN	TM
Initial body weight, kg	0.04 ± 0.17	0.04 ± 0.05
Final body weight, kg	1.05 ± 0.15	1.04 ± 0.10
Weight gained, kg	1.01 ± 0.42	1.00 ± 0.01
Average total feed intake, kg	2.15 ± 1.48	2.18 ± 1.12
Average daily feed intake, g	76.78 ± 4.30	77.86 ± 3.10
Feed conversion ratio, FCR	2.13	2.18
Feed conversion efficiency, FCE	0.47	0.46
Mortality, %	1.00	1.00

ab: means with different superscripts differ significantly at $P < 0.05$.
TN, non-medicated group; TM, medicated group.

Table 3. Effect of medication on hematological parameters of broiler chickens at starter phase

Parameters	TN	TM
Packed cell volume, %	29.50 ± 1.55	29.01 ± 1.05
Hemoglobin, gdL^{-1}	10.02 ± 0.65	9.94 ± 0.55
Red blood cell, 10 xuL	1.42 ± 0.01	1.37 ± 0.01
WBC, 10 xuL	1,765.00 ± 18.00	1,793.00 ± 20.05
MCV, fl	20.77	21.18
MCH, pg	70.56	72.55
MCHC, %	33.97	34.26

ab: means with different superscripts differ significantly at $P < 0.05$.
WBC, white blood cell counts; MCV, mean cell volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; TN, non-medicated group; TM, medicated group.

Table 4. Effect of medication on performance characteristics of broiler chickens at finisher phase

Parameters	TN	TM
Initial body weight, kg	1.05 ± 0.15	1.04 ± 0.10
Final body weight, kg	3.58 ± 0.25^{a}	2.56 ± 0.04^{b}
Weight gained, kg	2.53 ± 0.42^{a}	1.52 ± 0.01^{b}
Average total feed intake, kg	7.70 ± 1.26	7.60 ± 1.10
Average daily feed intake, g	275.00 ± 4.50	271.43 ± 3.05
Feed conversion ratio, FCR	3.04	5.00
Feed conversion efficiency, FCE	0.33	0.20
Mortality, %	5.00	7.00

ab: means with different superscripts differ significantly at $P < 0.05$.
TN, non-medicated group; TM, medicated group.

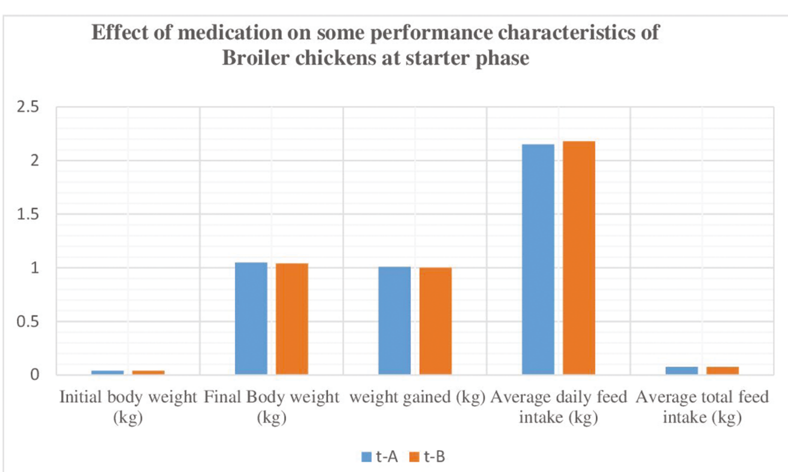

Figure 3. Effect of medication on some performance characteristics of broiler chickens at starter phase.

Table 5. Effect of medication on hematological parameters of broiler chickens at finisher phase

Parameters	TN	TM
Packed cell volume, %	28.50 ± 0.05[a]	16.52 ± 0.02[b]
Hemoglobin, gdL^{-1}	11.02 ± 0.01[a]	4.50 ± 0.01[b]
Red blood cell, 10 xuL	1.62 ± 0.02[a]	1.07 ± 0.01[b]
WBC, 10 xuL	1,775.00 ± 10.05[b]	2,286.00 ± 10.50[a]
MCV, fl	17.60	15.44
MCH, pg	68.02	42.06
MCHC, %	38.67	27.24

ab: means with different superscripts differ significantly at $P < 0.05$. WBC, white blood cell counts; MCV, mean cell volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; TN, non-medicated group; TM, medicated group.

the birds. Meanwhile, birds in medicated group recorded lower mortality rate (5.00%) than non-medicated group (7.00%) although the two rates were still within the permissible range of mortality rate for chickens. This negates the earlier report by Dumonceaux et al. (2006), that non-medicated birds can come down with alarming mortality rates. This un-alarming mortality rate may be linked to the quality of nutrients available for the chickens via feed given to them which actually assisted them to build some level of immunity against disease.

In terms of blood indices at finisher stage as shown in Table 5, our study demonstrated that medication influenced various blood parameters in broiler chickens. Medicated birds exhibited higher hematocrit levels significantly ($P < 0.05$) than the non-medicated group. This finding is consistent with previous studies that have reported that antibiotics can stimulate erythropoiesis. These results indicate that medication can have positive effects on the physiological well-being and health status of broiler chickens as earlier reported by Danzeisen et al. (2011). Nevertheless, non-medicated broiler chickens can still grow well though at lower rate if given the required nutrients.

Conclusion and Recommendation

The findings of this work reveal that non-medicated broilers may not come down with alarming mortality rate if well-fed and raised in a bio-secured environment. Therefore, in line with the need to avoid the use of antibiotics because of the associated detriments, broiler farmers should consider giving the birds high-quality feed, use of organic supplements, probiotics, and prebiotics to improve the health status and ensure better performance of their birds. Also, further research should be conducted to evaluate the cost-effectiveness of no medication regime in broiler chicken production.

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Conflict of interest statement

The authors are not reporting any potential conflict of interest concerning this publication.

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