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The Impact of Baking Soda Supplementation on the Growth Performance of Broiler

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ABSTRACT

This study investigates the effects of Sodium bicarbonate supplementation on the growth rate of broilers, considering diverse parameters such as mean weight, cumulative feed consumption, and Feed Conversion Ratio (FCR). Twenty-five (25) birds were shared equally into five different groups at random, group one was the control, while groups 2, 3, 4, and 5 received sodium bicarbonate in feeds at a concentrations of 1g/kg, 2g/kg, 4g/kg and 8g/kg respectively. The primary data analysis reveals nuanced outcomes. While Sodium bicarbonate demonstrated no significant effect on the mean weight in the fifth week, distinct patterns emerged in cumulative feed consumption, with group 3 exhibiting the highest intake. Notably, optimal Feed Conversion Ratio (FCR) was observed in group 3, emphasizing the potential benefits of Sodium bicarbonate supplementation. Recommendations include exploring optimal Sodium bicarbonate levels, integrating disease management strategies, and considering practical implementation in broiler diets. This study contributes valuable insights for poultry farmers aiming at enhancing broiler growth and feed efficiency through strategic Sodium bicarbonate supplementation. Long-term investigations are suggested to unveil sustained effects over successive production cycles.
Keywords: Baking soda, Sodium bicarbonate, Broiler, Growth performance, Feed conversion ratio

INTRODUCTION

The term "poultry" is used to refer to birds that have been domesticated to reproduce and grow in captivity and produce economically valuable products like; eggs, meat, manure etc. The birds include species like; ducks, turkey, quails, swan, pigeon, guinea fowl, pheasant etc [1]. Broilers are a subset of poultry raised mainly for the production of meat [2] the rearing of chickens for meat production has become very popular since it's conception, half a century ago. Broilers are amongst the fastest growing farmed species, due to intensive genetic selection, broilers can weigh up to 50g and grow to a slaughter weight of 2kg at 37 days of age, more modern breeds can gain weight at the rate of 50-55g a day [3]. In order to maintain productivity of poultry, proper care must be provided, things like housing, water, feed, medication etc. Proper feeding translates to proper growth and productivity in poultry. Feed is any material that is capable of being digested, absorbed, and utilized after it has been ingested by an animal [4]. Different poultry species may require different feed formulas to maintain their productivity. For example, turkeys may require a higher amount of protein, minerals and vitamins in their feed than that of chickens [1]. Broilers are fed with different formulations at different stages of their growth; they get starters from 0-6weeks of age and finisher from 6 weeks till they reach market size from between 7-8 weeks. Quality feed may increase the feed conversion ratio in broilers. Conversion ratio referred to the amount of feed needed to produce one pound or one kilogram of live weight. Current feed conversion ratio in the broiler industry averages about 0.84kg of feed per 0.45kg of gain for male and 0.88kg of feed per 0.45kg of gain for female [5]. The broiler industry continually seeks innovative strategies to optimize growth performance and feed efficiency while ensuring the well-being of birds. Dietary supplementation with additives such as probiotics, enzymes, and organic acids has been extensively studied for their potential to enhance nutrient utilization and promote growth in broilers. Baking soda (sodium bicarbonate), a common household ingredient, has emerged as a promising dietary supplement due to its alkaline properties and ability to modulate gastrointestinal pH. Sodium bicarbonate ($NaHCO_3$) dissociates in water to form ions. The primary ions involved are: Sodium Ion (Na^+): Sodium is a positively charged ion that results from the dissociation of the sodium bicarbonate molecule. Bicarbonate Ion (HCO_3^-): Bicarbonate is a negatively charged ion that also forms as a result of the dissociation of sodium bicarbonate. The sodium obtained from this is essentially for the physiology of animals, including broilers. Sodium is crucial for the active transport of nutrients across cell membranes, especially in the small intestine. Active transport mechanisms facilitated by sodium move essential nutrients, such as glucose and amino acids, from the intestinal lumen into the cells lining the intestine [6]. Several mechanisms involving sodium contribute to nutrient uptake in the small intestine, ensuring the efficient absorption of essential substances for growth and development. Co-Transporter (SGLT): One of the primary mechanisms of active transport in the small intestine involves the sodium-glucose co-transporter (SGLT). SGLT is responsible for the absorption of glucose and other sugars. Sodium ions, actively transported from the cytoplasm of the epithelial cells into the extracellular space, create a concentration gradient. This gradient allows for the co-transport of glucose against its concentration gradient, ensuring its uptake from the intestinal lumen into the enterocytes [7]. Sodium-coupled Amino Acid Transport: transport of amino acids across the small intestine is facilitated by sodium-coupled transporters. Sodium-dependent transport systems, such as the sodium-amino acid co-transporters (SAACT), play a crucial role in the absorption of amino acids from the intestinal lumen. Sodium gradients generated by active transport mechanisms provide the energy needed to drive the uptake of amino acids into the enterocytes [8]. Sodium-Short Chain Fatty Acid Co-Transport: Short-chain fatty acids (SCFAs) are absorbed in the small intestine through sodium-dependent co-transport mechanisms. SCFA transporters facilitate the absorption of these important metabolites, contributing to energy homeostasis and influencing gut health [9].

Maintaining Electrolyte Balance

Sodium, in collaboration with other electrolytes like potassium, helps maintain proper electrolyte balance critical for efficient nutrient absorption. The sodium-potassium pump is instrumental in preserving the electrochemical gradient necessary for nutrient transport [10]. Cellular Growth and Maintenance: Sodium is implicated in cellular growth and maintenance. Proper electrolyte balance, including sodium, is vital for cell integrity and function. Cellular processes such as protein synthesis and enzyme activity rely on the maintenance of electrolyte homeostasis. Adequate sodium levels contribute to the structural and functional integrity of cells, supporting overall growth and development. Electrolyte Homeostasis and Growth: Electrolyte homeostasis, including sodium balance, is closely linked to overall growth. The regulation of extracellular fluid volume, blood pressure, and nerve signal transmission—all influenced by sodium—contributes to an optimal physiological environment for growth. Disruptions in electrolyte balance can impact cellular functions, potentially affecting growth and development [10].

Stimulating Enzyme Activity

Sodium ions can stimulate the activity of digestive enzymes, including those involved in macronutrient breakdown. Optimal enzyme activity is crucial for the effective digestion and absorption of nutrients [11]. Enzyme Activation Mechanisms: Sodium contributes to enzyme activation through several mechanisms. It interacts with enzymes directly, altering their conformation and enhancing their catalytic activity Additionally, sodium ions act as cofactors for certain enzymes, participating in the formation of enzyme-substrate complexes and promoting efficient substrate binding and catalysis [12]. Role in Enzyme Activation: Sodium is involved in enzyme activation cascades, particularly in signal transduction pathways. Enzymes such as kinases and phosphatases, critical for cellular signaling, often require sodium ions for their activation. These enzymes regulate processes like cell growth, differentiation, and apoptosis, and the presence of sodium is essential for their proper functioning. A few research has been carried out on the effects of sodium bicarbonate on the growth performance of broilers. In a study by [13] where sodium bicarbonate was supplemented at 1% in the water of broilers, it was discovered that baking soda had adverse effects on the growth rate of birds. It causes abnormal heart and liver growth and caused a disease called Ascites. It is a type of disease that leads to abdominal swelling caused by accumulation of fluid, [13] also found something similar. In his experiment, he discovered that in birds dietary supplementation of 4.0% sodium bicarbonate resulted in poor growth performance and higher mortality. In addition, Sodium bicarbonate higher than 1.0% affected blood biochemical parameters and caused renal lesions [14].

MATERIALS AND METHODS

Experimental Design: A total of 25 broiler chicks were acquired at day-old and underwent a meticulous two-week brooding period, during which they received attentive care to mitigate

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mortality risks. The experimental animals were housed in a controlled environment, shielded from direct sunlight and rainfall. A consistent 12-hour light/dark cycle was maintained to ensure their overall well-being. Adequate access to food and water was provided throughout the study period. Rigorous daily observations were conducted to monitor any alterations in physical appearance and feeding patterns. The broilers were systematically weighed at 3-day intervals using a sensitive weighing scale. Chicks were randomly allocated to five treatment groups, each consisting of five animals. The groups were designated as Control (0g/kg), 1g/kg, 2g/kg, 4g/kg, and 8g/kg of baking soda in the feed. The experiment was conducted for five weeks, during which the birds were provided with *ad libitum* access to feed and water. Feed intake, body weight gain, and mortality were recorded weekly throughout the experimental period. Feed conversion ratio (FCR) was calculated as the ratio of feed consumed to body weight gain. Data analysis was reported in mean ± SEM using one way analysis of variance (ANOVA). The level of significance used was at p-value ≤ 0.05.

RESULTS

The dynamic changes in the weights of birds across different experimental groups over a five-week period. The values represent mean weights with associated standard errors of the mean (SEM) for each group at various time points. The result shows that after one week, the birds in group 1 did not increase in weight, rather there was some reduction in weight from 394.2± 32.76 to 389 ± 43.53. Weight loss was also observed in group 5 which reduced from 374 ±13.50 at the start of the experiment to 332.4 ±80.63. However, groups 2,3and 4 had increase in weight, from; 375.2±44.37, 408.6 ±15.15 and 291.2 ±45.03 to 553±33.07, 508±15.27 and 478±32.05 respectively. On the third week, there was an increase in the average weight of birds for all group. On the fourth and final week of the experiment, there was an increase in the average weight of birds in all the groups, with group 1 having an average weight of 979.6 ± 166.42, group 2 have an average weight of 1144 ± 73.05, group 3, 4 and 5 having an average weight of 1152 ± 17.15, 1074 ± 63.84 and 915.6 ± 138.72 respectively. This means that group 3 has the highest mean weight. The results of Table 1 is represented on a bar chart in fig .1 Table 2 contains the feed consumption patterns (in grams) across different experimental groups (grp1, grp2, grp3, grp4, and grp5) throughout the five-week experimental period. The result shows that on the first week, group 3 consumed 1639 grams of feed, which was the highest quantity of feed consumed as compared to other groups. Group 3 was closely followed by group 1 which consumed 1589 grams of feed in the first week of the experiment, altogether this feed consumption did not translate into average weight gain in the group due to disease. Group 5 consumed the least quantity of feed (1280 grams) in week one. On the second week of the experiment, group 3 still had the highest feed intake of all the groups at 2025 grams. This trend progressed into the third, fourth and fifth week. Following closely behind was group 4 which consumed 1990 grams of feed on the second week of the experiment. Group 4 continued on that trend from week two to the end of the experiment. Group 5 consumed the least amount of feed from week one (1280 grams) to the end of the experiment (1969 grams). Group 2 consumed the third highest quantity of feed right behind group 4. [Table 2] This data are well represented in fig 2. Table 3 provides a cumulative record of feed consumption per week (in grams) for all groups over a five-week period. This table shows that group 3 consumed the highest quantity of feed throughout the five week duration of the experiment, consuming a total of 5.3kg of feed at the fifth week. Group 4 had the second highest feed intake at 5.2 kg of feed at the fifth week, followed by group 2 at 5.19kg of feed at the fifth week. Group five had the least feed intake at just 3.7kg of feed at the fifth week of the experiment. [Table 3] This data is well represented in fig 3. Table 4 outlines the weekly growth of birds (in grams) across different experimental groups (Grp1, Grp2, Grp3, Grp4, and Grp5) over a four-week period. The result shows that after the first week, group 1 and group 5 experienced a negative growth of -5.2 and -41.6 respectively, the negative growth rates were due to disease encountered in those groups during the course of the experiment. Group 4 had the highest growth rate in the first week at 179.8g followed by group 2 at 177.8g, group 3 had the growth rate of 99.4g. On the second week, group 3 had the highest growth rate of 175.6g followed by group 2 with growth at 168.4g and further followed by group one. When the growth increase in weights were summed up, it was observed that group 4 had the highest increase of 782.8g, followed by group 2 which had an increase of 768.8g, group 3 comes next with an increase of 743.4g. [Table 4]. Table 5 outlines the weekly feed conversation ratio of birds across different experimental groups over a four-week period. Feed Conversion Ratio (FCR), as FCR is traditionally a positive ratio representing the amount of feed required to produce a unit of body weight or product. The FCR is calculated by dividing the amount of feed consumed by the weight gain or product output. The negative figures found in group 1 and group 5 (-350.96 and -37.01) was as a result of mortality, and disease which reduced the growth rate. During the fourth week, after disease was kept in check, and mortality had been curtailed, it was observed that the best FCR was in group 5 at 4.98. A lower

Feed Conversion Ratio (FCR) is beneficial in poultry farming as it signifies improved efficiency in converting feed into body weight. This efficiency reduces the overall cost of production by minimizing feed expenses [Table 5].

Table: 1 weight of the bird during the experimental period

	weight of the bird during the experimental period				
	grp1	grp2	grp3	grp4	grp5
start	$394.2 \pm 32.76_{ab}$	$375.2 \pm 44.37_{ab}$	$408.6 \pm 15.15_{b}$	$291.2 \pm 45.03_{a}$	$374 \pm 13.50_{ab}$
week1	$389 \pm 43.53_{ab}$	$553 \pm 34.07_{c}$	$508 \pm 15.27_{bc}$	$471 \pm 32.05_{abc}$	$332.4 \pm 80.63_{a}$
week2	$492 \pm 76.90_{a}$	$721.4 \pm 40.54_{b}$	$683.6 \pm 19.67_{b}$	$618 \pm 41.40_{b}$	$439 \pm 97.72_{a}$
week3	$722.4 \pm 87.26_{ab}$	$906 \pm 17.20_{b}$	$845 \pm 31.30_{b}$	$709.6 \pm 91.15_{ab}$	$521 \pm 130.72_{a}$
week4	$979.6 \pm 166.42_{a}$	$1144 \pm 73.05_{a}$	$1152 \pm 17.15_{a}$	$1074 \pm 63.84_{a}$	$915.6 \pm 138.72_{a}$

Figures in the same column having the same alphabetical subscript are not significantly different from each other. Result is presented in mean ± SEM, n =5, p≤ 0.05

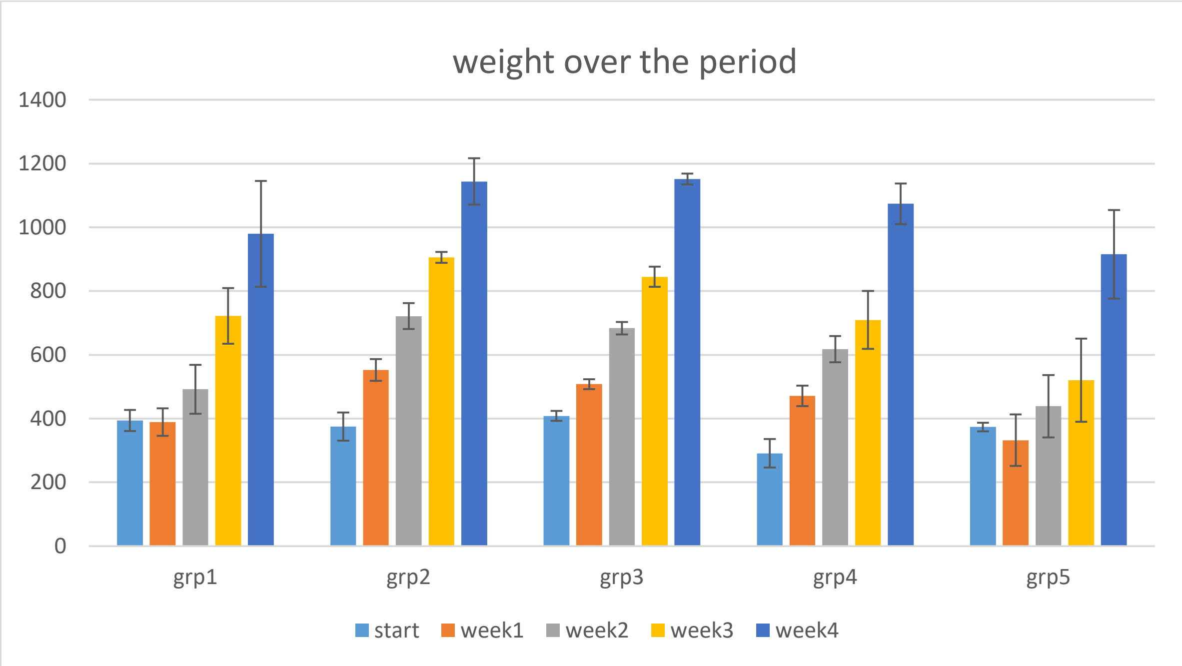

Fig 1: representation of birds' weight in bar chart

Table 2: Feed Consumption

	Feed Consumption (g)				
	grp1	grp2	grp3	grp4	grp5
WEEK1	1589	1406	1639	1550	1280
WEEK2	1825	1965	2025	1990	1540
WEEK3	2090	2220	2325	2223	1340
WEEK4	2103	2713	2770	2740	1746
WEEK5	2185	2485	2530	2495	1969

N=5

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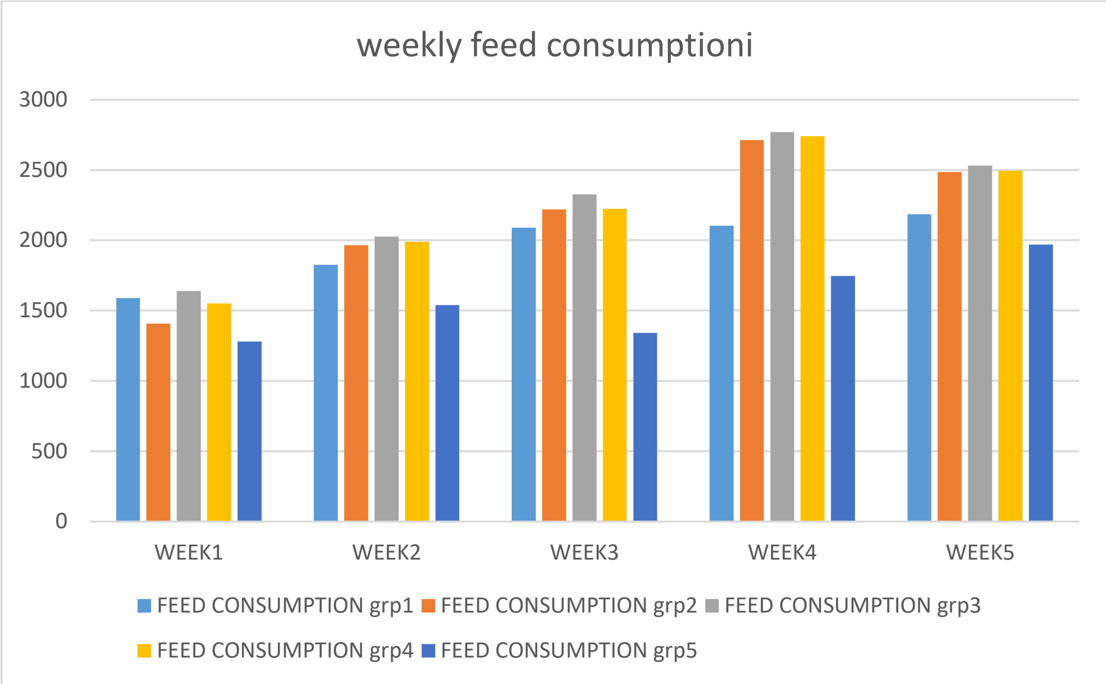

Fig 2: Feed consumption expressed in bar chart

Table 3 cumulative record of feed consumed per week

	cumulative record of feed consumed per week (g)				
	grp1	grp2	grp3	grp4	grp5
WK1	1589	1406	1639	1550	1280
WK2	3414	3371	3664	3540	2820
WK3	3915	4185	4350	4213	2880
WK4	4193	4933	5095	4963	3086
WK5	4288	5198	5300	5235	3715

N=5

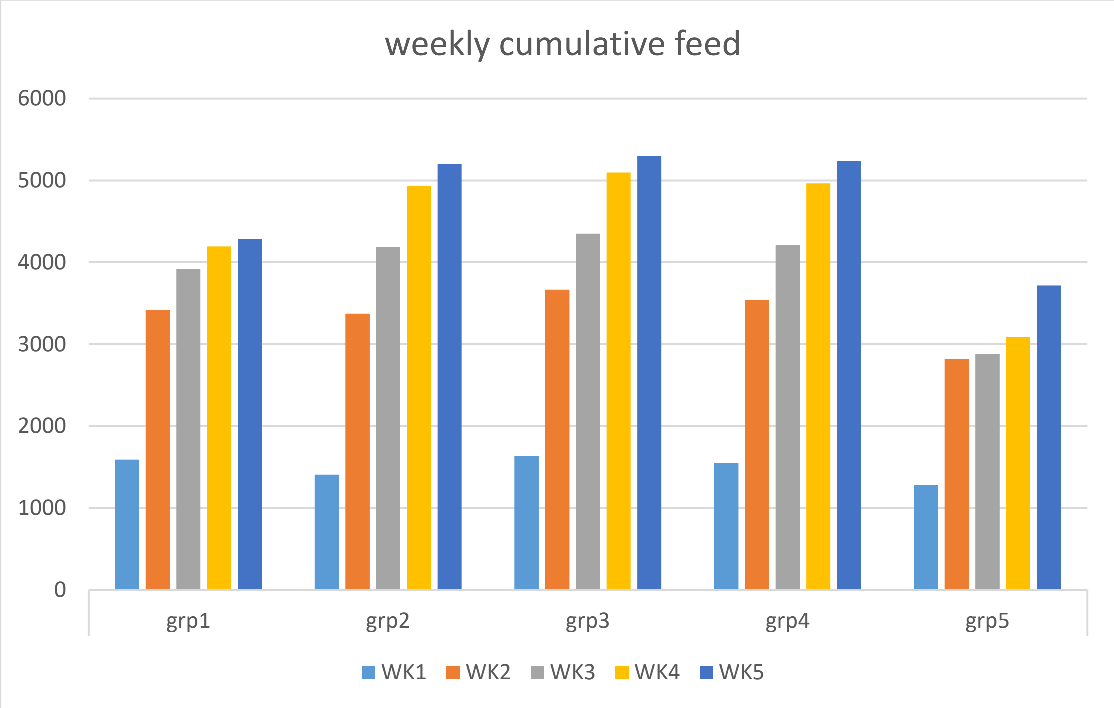

Fig 3: Cumulative feed intake

Table 4: weekly growth of the birds

		weekly growth of the birds (g)			
weeks	Grp1	Grp2	Grp3	Grp4	Grp5
Week 1	-5.2	177.8	99.4	179.8	-41.6
Week2	103	168.4	175.6	147	106.6
Week3	230.4	184.6	161.4	91.6	82
Week4	257.2	238	307	364.4	394.6

Table 5 feed conversion ratio

	feed conversion ratio				
weeks	Grp1	Grp2	Grp3	Grp4	Grp5
Week 1	-350.96	11.05	20.37	11.06	-37.01
Week2	20.29	13.18	13.24	15.12	12.57
Week3	9.12	14.69	17.16	29.91	21.29
Week4	8.49	10.44	8.24	6.84	4.98

DISCUSSION

Based on the analysis of the primary data, the following findings were discovered from the study. The results of table 1 had a negative growth rate at the first week in group 1 and 5 this could have been because of disease the birds in these groups were infected with disease of which they were treated with an anti-coccidiostat. After treatment the birds weight started improving in subsequent weeks. Group 3 had the highest mean weight in all the groups, which suggests that a supplementation of sodium bicarbonate at 2g/kg can have the best possible positive effect on the weight of broilers. The results of observed feed consumption patterns (Table 2) among the experimental groups indicate notable variations in the dietary habits of broilers throughout the study. Group 3 consistently exhibited the highest feed intake. In contrast, Group 5 consumed the least amount of feed during the entire experiment, indicating potential concerns about nutritional adequacy. Birds in group 2 and 3 consumed more feed than the control group, this suggests that sodium bicarbonate can improve feed intake in

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birds, proper feed intake can lead to improves growth rate. The graphical representation of these trends visually reinforces the disparities in feed consumption among the groups.The results from table 4 showed that birds in group 1 and Group 5 experienced a reduction in weight after the first week, attributed to disease-related factors. However, other groups with supplemented sodium bicarbonates (groups 2,3, and 4) had relatively higher growth rates with highest recorded in group 3 The best results came from group 2, 3 and 4 on week four of the experiment. This suggests that sodium bicarbonate may have a positive effect on the growth rate of birds. The Feed Conversion Ratio (FCR) analysis provides insights into the efficiency of feed utilization. The negative FCR values in Group 1 and Group 5 during the early weeks were attributed to disease-related mortality, which affected the growth rate. However, in the later weeks, after controlling for disease and mortality, Group 5 demonstrated the best FCR, indicating improved efficiency in converting feed into body weight. This suggests the resilience of Group 5 in optimizing feed utilization once health issues were addressed though the feed consumption of this group was low.

CONCLUSION

The study reveals that Sodium bicarbonate demonstrated no significant impact on the mean weight of broilers in the fifth week. However, it is noteworthy that the highest mean weight was observed in group 3, followed closely by group 2. These findings suggest a potential influence of Sodium bicarbonate on broiler growth performance. The cumulative feed consumption data highlight distinct patterns among the groups. Group 3 exhibited the highest cumulative consumption, closely trailed by group 4. This observation suggests that the inclusion of Sodium bicarbonate at a rate of 2g/kg notably enhances feed intake in broilers. The implications of increased feed intake warrant further investigation and consideration in broiler nutrition study. The analysis of Feed Conversion Ratio (FCR) indicates that, on average, group 3 achieved the most favorable FCR. However, it is interesting to note that the best FCR was recorded in group 5 during the fourth week of the experiment, after disease management measures were implemented. This underscores the potential interactive effects of Sodium bicarbonate and disease control on broiler performance.

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