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Influence of Sodium Acetate, Sodium Propionate and their Combination on Nutrient Digestibility and Blood Profile of Broiler Starters

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Target Audience*: Animal scientists and researchers, Feed millers, Broiler farmers*

Abstract

In a 21-day feeding trial, the effects of sodium acetate, sodium propionate and their combination on nutrient digestibility and blood profile of broiler starter was investigated. Two hundred and forty one-day old Arbor Acre broiler chicks were randomly distributed into five treatments with six replicates of eight birds each in a completely randomised design. Treatment 1 was a basal diet with no supplement while treatment 2 comprised of 0.01% oxytetracycline. Treatments 3 and 4 had 0.4% sodium acetate and 0.4% sodium propionate respectively while treatment 5 contained 0.4% sodium acetate + 0.4% sodium propionate. At day 21, 5mL of blood sample was collected from 2 birds per replicate for haematological and serum biochemical analyses. On day 16, two birds per replicate were housed individually in metabolic cages and allowed to acclimatize for three days. On days 19 to 21, excreta samples were collected, weighed, pooled on replicate basis and dried for nutrient digestibility assay. Ether extract digestibility coefficients of birds fed antibiotic and sodium propionate diets differ significantly but were similar to birds on the other treatment groups. Significantly lower (P<0.05) packed cell volume was observed in birds fed sodium acetate compared with those on other diets. Haemoglobin concentration on birds on sodium acetate was similar to those fed combination of sodium acetate + sodium propionate. Significantly (P<0.05) higher red blood cells were observed in birds on sodium acetate supplemented diet. Lymphocytes counts of birds on basal diet and antibiotic diet were higher than birds fed sodium acetate diet and sodium acetate + sodium propionate supplemented diet. Albumin concentration of birds on sodium acetate and sodium propionate diets were identical with birds fed other dietary treatments. Phosphorus concentration in birds on basal, antibiotic or sodium acetate supplemented diets were significantly (P<0.05) lower than birds on the other treatments. Alanine amino transferase concentration was high in birds fed sodium acetate + sodium propionate diet compared to birds on other diets. It can be concluded that sodium acetate and sodium propionate can be considered as viable alternatives to antibiotics in broiler starter diets in terms of improved blood metabolites.

Keywords*: Organic salts, Nutrient digestibility coefficient, Blood constituents, Broiler chicken*

Description of Problem

The use of antibiotics as growth promoters in modern poultry industry for improved production performance of birds has been a successful practice for more than decades. However, resistance occurs because of the massive use of antibiotics, resulting in residual effects in animal products [1]. Antibiotics resistance is a form of drug resistance whereby populations of microorganisms, usually bacteria species, are able to survive after exposure to one or more antibiotics [2]. As a result of this, need for a

viable alternative to antibiotics becomes imperative.

Organic acids [3], probiotics [4], prebiotics [5], symbiotics [6] among others are alternatives growth promoters used in poultry nutrition. In recent years, there has been an increase in the use of organic acids as substitutes for antibiotics growth promoters. Organic acids and their salts have been used in poultry diets and drinking water for decades and seem to elicit a positive response in growth performance [7]. Organic acid supplementation, irrespective of type and level of acid used, had been reported to have beneficial effects on the performance and gut morphology of broiler chickens [8].

Amongst the organic acids and their salts used in poultry production, short chain fatty acids (acetic, butyric and propionic acids) had been reported to have a positive impact on growth performance and improved gut histomorphology in broilers [9], [10]. These organic acids have been reported to exhibit antimicrobial properties by reducing intestinal pH when dissociated. They are lipid soluble which have the ability to diffuse into cell membranes in the un-dissociated form, before dissociated to release protons that decreases intracellular pH thereby disrupting the normal actions of certain types of bacteria including *Salmonella* spp., *Escherichia coli*, *Clostridia* spp., *Listeria* spp. and some coliforms [11], [12]. It was the objective of this study to investigate the effects of sodium acetate, sodium propionate and their combination on apparent nutrient digestibility and blood metabolites of broiler starters.

Materials and Methods

Experimental site

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, University of Ibadan, Oyo State in the South West geopolitical zone of Nigeria, within the tropical rain forest region.

Experimental diets and management of birds

Two hundred and forty (240) one-day old Arbor Acre broiler chicks were purchased from a reputable commercial hatchery. The birds were randomly distributed into one of the five dietary treatments with six replicates of eight birds each in a completely randomized design. Treatment 1 was a basal diet with no supplement (negative control) while treatment 2 comprised of basal diet + 0.01% oxytetracycline (positive control). Treatment 3 had the basal diet + 0.4% sodium acetate, treatment 4 was basal diet + 0.4% sodium propionate, while treatment 5 contained the basal diet + 0.4% sodium acetate + 0.4% sodium propionate. Experimented diets were formulated according to recommendation of [13] as shown in Table 1. The birds were fed experimental diets and provided with clean water for the period of 21 days.

Experimental design

The experimental design for this study is a completely randomised design (CRD)

Data and Sample Collection

Nutrient digestibility study

On day 16, two birds per replicate were housed individually in metabolic cages and were allowed to acclimatize for three days. On days 19 to 21, excreta samples were collected and weighed. About 10% aliquot excreta samples were pooled on replicate basis, dried, ground and stored in airtight plastic container for proximate analysis. Analyzed values were used to calculate nutrient digestibility coefficients. Nutrient digestibility coefficient was calculated as:

$$\text{Nutrient Digestibility Coefficient} = \frac{\text{nutrient intake} - \text{nutrient output}}{\text{nutrient intake}}$$

Table 1: Gross composition (g/kg) of starter diets fed to broiler chicks

Ingredients g/kg	Negative control (NC) (Basal diet)	Positive control (Antibiotics)	NC + sodium acetate	NC + sodium propionate	NC + sodium acetate + sodium propionate
Corn	555.00	555.00	555.00	555.00	555.00
Soyabean meal	372.00	372.00	372.00	372.00	372.00
Fish meal	25.00	25.00	25.00	25.00	25.00
Wheat offal	15.00	14.895	11.00	11.00	7.00
Dicalcium phosphate	15.00	15.00	15.00	15.00	15.00
Premixes	2.50	2.50	2.50	2.50	2.50
Limestone	8.00	8.00	8.00	8.00	8.00
DL-methionine	2.50	2.50	2.50	2.50	2.50
L-lysine	2.50	2.50	2.50	2.50	2.50
Salt	2.50	2.50	2.50	2.50	2.50
Antibiotics	0.00	0.105	0.00	0.00	0.00
Sodium acetate	0.00	0.00	4.00	0.00	4.00
Sodium propionate	0.00	0.00	0.00	4.00	4.00
Sodium acetate and sodium propionate	0.00	0.00	0.00	0.00	0.00
TOTAL	1000	1000	1000	1000	1000
Calculated nutrient (g/kg)					
Crude protein	232.290	232.272	231.610	231.780	230.930
Energy ME(kcal/kg)	3009.820	3009.624	3002.340	3002.340	2994.860
Crude fat	37.005	37.000	36.829	36.829	36.829
Crude fiber	39.700	39.691	39.360	39.360	39.360
Calcium	8.749	8.749	8.744	8.744	8.744
Total phosphorus	7.374	7.372	7.320	7.321	7.321
Non-phytate P	3.926	3.926	3.926	3.926	3.926
Ca:NPP	2.228	2.228	2.227	2.227	2.227

*Supplied the following per kg diet: vitamin A, 5484 IU; vitamin D3, 2643 ICU; vitamin E, 11 IU; menadione sodium bisulfie, 4.38 mg; riboflavin, 5.49 mg; d-pantothenic acid, 11 mg; niacin, 44.1 mg; choline chloride, 771 mg; vitamin B12, 13.2 µg; biotin, 55.2 µg; thiamine mononitrate, 2.2 mg; folic acid, 990 µg; pyridoxine hydrochloride, 3.3 mg; I, 1.11 mg; Mn, 66.06mgg; Cu, 4.44mg; Fe 44.1mg; Zn, 44.1mg; Se, 300µg.
Source: [10]

Collection of blood samples

Blood sample (5mL) was collected on day 21 for haematological and serum biochemical analyses. Two birds per replicate were bled from the jugular vein using sterilized needles. Samples were identified and fractionated, with 2mL put into a tube containing anticoagulant (EDTA) for haematological indices and 3mL kept in a tube without anticoagulant for serum biochemical assay.

Haematological parameters of birds on experimental diets

Haematological parameters assayed for were packed cells volume (PCV), white blood cells (WBC), red blood cells (RBC), haemoglobin (Hb). Packed cell volume and haemoglobin were determined using micro haematocrit method and cyanmethehemoglobin method respectively as described by [14], RBC and WBC were determined using the improved Neubauer haemocytometer [15].

Serum biochemical indices of birds on experimental diets

Serum was obtained after centrifuging the blood samples at 3500 rpm (revolution per minute) for 15 minutes in an haematocrit centrifuge for the biochemical analysis using a spectrophotometer and it was assayed for creatinine, urea, total protein, albumin, and globulin, serum enzymes (Aspartate aminotransferase (AST), Alanine amino transferase (ALT), alkaline phosphate (ALP) using automatic analyzer [16], blood calcium and phosphorus. Total protein was determined using the biuret method as described by [17]. Albumin was determined using the bromocresol green (BCG) method as described by [18] and globulin was determined by difference of total protein and albumin. Alkaline phosphates (ALP), alanine amino transferase and aspartate amino transferase activity was determined using spectrophotometric methods as described by [19].

Proximate analysis

Diets and excreta samples were determined according to the official methods of analysis described by the Association of Official Analytical Chemist [20].

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using [21] at significance level ($P<0.05$) and means were separated using Tukey's HSD test.

Results

Nutrient digestibility coefficient of broiler chicken fed organic salts supplemented diets

The results of the effects of dietary supplementation of antibiotics and organic salts on nutrient digestibility coefficients are shown in Table 2. There were significant ($P<0.05$) differences among the treatment groups for ether extract and ash except for crude protein, crude fibre and nitrogen free extract which were identical. Ether extract digestibility coefficients of birds fed antibiotic and sodium propionate diets were similar to birds on the other treatment groups. Similarly, ash digestibility coefficients of birds fed basal diet and antibiotic diet did not differ significantly from birds on other dietary treatments.

Table 2: Nutrient digestibility coefficients of broiler chicken fed antibiotic and organic salts supplemented diets (0-21days)

Parameters	Treatments					P-Value
	Negative control (NC) (basal diet)	Positive control (PC) (antibiotic diet)	NC + SA	NC+ SP	NC+ SA + SP	
Crude protein	0.67 ± 0.07	0.71 ± 0.03	0.69 ± 0.01	0.70 ± 0.05	0.71 ± 0.07	0.6146
Crude fibre	0.74 ±0.06	0.78 ± 0.02	0.73 ± 0.01	0.73 ± 0.04	0.76 ± 0.05	0.2536
Ether extract	0.89 ± 0.02^{ab}	0.91 ± 0.01^{a}	0.89 ± 0.01^{ab}	0.88 ± 0.02^{b}	0.90 ± 0.02^{ab}	0.0678
Ash	0.73 ± 0.06^{b}	0.81 ± 0.02^{a}	0.75 ± 0.01^{ab}	0.79 ± 0.04^{ab}	0.75 ± 0.06^{ab}	0.0198
Nitrogen free extract	0.74 ± 0.06	0.76 ± 0.02	0.73 ± 0.01	0.72 ± 0.05	0.73 ± 0.06	0.6454

^{abc}Means with same alphabetical superscripts are not significantly different (p>0.05).

SA - Sodium acetate, SP - Sodium propionate

Table 3: Haematological parameters of broiler chicken fed antibiotics and organic salts supplemented diets (0-21 days)

Parameters	Treatments					P-Value
	Negative control (basal diet)	Positive control (antibiotic diet)	Negative control+ Sodium acetate	Negative control+ Sodium propionate	Negative control+ Sodium acetate+ Sodium propionate	
Packed cell volume (%)	33.17 ± 1.72^{ab}	35.33 ± 1.75^{a}	27.33 ± 1.75^{c}	32.83 ± 1.94^{ab}	30.83 ± 2.32^{b}	0.0001
Heamoglobin (g/dL)	10.99 ± 0.57^{a}	11.45 ± 0.96^{a}	9.11 ± 0.56^{b}	11.20 ± 0.49^{a}	10.33 ± 0.89^{ab}	0.0001
Red blood cells (x10^{6}µL)	3.34 ± 0.13^{bc}	3.50 ± 0.21^{b}	3.82 ± 0.08^{a}	3.36 ± 0.08^{bc}	3.27 ± 0.12^{c}	0.0001
White blood cells (x 10^{3}µL)	20344.7 ± 662.46^{a}	15403.0 ± 641.27^{b}	14926.7 ± 438.53^{b}	19601.3 ± 651.31^{a}	19600.0 ± 195.55^{a}	0.0001
Platelets	124541 ± 2368.63^{c}	132521 ± 4946.22^{b}	117667 ± 1366.26^{d}	133167 ± 1169.05^{b}	162000 ± 707.11^{a}	0.0001
Lymphocytes (%)	67.83 ± 1.72^{a}	66.17 ± 4.67^{ab}	62.33 ± 3.08^{bc}	60.50 ± 3.51^{c}	60.50 ± 1.87^{c}	0.0001
Heterophils (%)	24.83 ± 1.17^{b}	37.83 ± 3.66^{a}	38.33 ± 4.32^{a}	38.17 ± 2.40^{a}	33.33 ± 2.16^{a}	0.0008
Eosinophils (%)	3.33 ± 0.52^{ab}	4.00 ± 0.89^{a}	4.17 ± 0.75^{a}	4.33 ± 1.21^{a}	2.33 ± 0.82^{b}	0.003
Basophils (%)	0.67 ± 0.52	1.00 ± 0.89	1.17 ± 0.75	0.50 ± 0.54	0.67 ± 0.52	0.4148

^{abc}Means with same similar superscripts are not significantly different (P>0.05)

Haematological parameters of broiler chicken fed antibiotics and organic salts supplemented diets

The haematological parameters of broiler chickens fed diets supplemented with antibiotics and organic salts are presented in Table 3. Diets exhibited significant ($P<0.05$) influence on all the haematological parameters measured except for basophils which showed no significance ($P>0.05$) difference among the treatment groups. Significantly lower ($P<0.05$) packed cell volume (PCV) was observed in birds fed sodium acetate compared with those on other dietary treatments. PCV of birds on antibiotic diet were higher ($P<0.05$) than those fed combination of sodium acetate + sodium propionate. Haemoglobin concentration on birds on sodium acetate was similar to those fed combination of sodium acetate + sodium propionate and was significantly ($P<0.05$) lower than what was recorded for birds on other treatment groups. Significantly ($P<0.05$) higher red blood cell ($3.82\ x10^6 \mu L$) was observed in birds on sodium acetate supplemented diet compared to birds fed other dietary treatments. White blood cells of birds fed sodium propionate, combination of sodium acetate + sodium propionate and the basal diets were significantly ($P<0.05$) higher than those on sodium acetate and antibiotic supplemented diets. Highest platelet counts (162000) was recorded for birds on combination of sodium acetate + sodium propionate while the least platelets counts (117667) was observed in fed sodium acetate supplemented diet. Lymphocytes counts of birds on basal diet (67.83%), antibiotic diet (66.17%) were higher than lymphocyte counts of birds fed sodium propionate (60.50%) diet and the combination of sodium acetate + sodium propionate (60.50%) supplemented diet. Similar heterophils were observed in birds on antibiotic diet (37.83%) and organic salts which were significantly ($P<0.05$) higher than the value obtained for birds fed the basal diet (24.83%). Eosinophils of birds on antibiotics diet and the organic salts supplemented diets were similar to that of birds on basal diet.

Serum biochemical indices of broiler chicken fed antibiotics and organic salts supplemented diets

The results of the effect of dietary supplementation of antibiotic and organic salts on serum biochemical indices of broiler chicken are shown in Table 4. The serum total proteins of birds on antibiotic diet differ ($P<0.05$) significantly from the other dietary treatments. It was significantly ($P<0.05$) higher than what was obtained in birds on other treatment groups. Albumin concentration of birds on sodium acetate and sodium propionate diets were identical with birds fed other dietary treatments. Diets had no significant ($P>0.05$) influence on the creatinine and urea concentration of birds on different treatment groups. Highest calcium concentration (21.29 ± 0.65) was recorded for birds on basal diet with least calcium concentration recorded for birds on sodium propionate (10.91 ± 0.89) and the combination (12.45 ± 1.03). Phosphorus concentration in birds on basal, antibiotic or sodium acetate supplemented diets were significantly ($P<0.05$) lower than phosphorus in birds on other treatment groups. Alanine amino transferase concentration was high in birds fed sodium acetate + sodium propionate diet compared to birds on other diets. Aspartate amino transferase concentration of birds fed basal diet was similar to those on sodium propionate diet and the combination.

Discussion

Nutrient digestibility coefficient of broiler chicken fed organic salts supplemented diets

Organic acids normally used as an acidifier in poultry feeds have been considered to be viable alternatives for improving nutrient

digestibility. The results from the present study showed that crude protein, crude fibre and nitrogen free extract were not influenced by the dietary treatments. The results on crude protein and crude fibre agreed with findings of [22] who reported that amino acid digestibility and crude fibre was consistently lower at 21 days for chicks fed 4 and 6% gluconic acid in broiler diets. This response was probably at least partially due to an increase in the digesta passage rate that caused mild diarrhoea, which was visually observed in the chicken. Crude protein, dispensable and indispensable amino acids were not affected by the addition of organic acid in the broiler diets [23]. They did not observe a synergistic effect of microbial phytase and dietary citric acid on amino acid digestibility. However, [24, 25] reported that supplementation of formic acid (0.5% or 1.0%) in broiler finisher diet improved crude protein (72.5% or 73.5%, respectively) as compared with control (56.4% DM and 60.7% CP). Also, [26] reported that broilers fed the control diet (without microbial phytase enzyme and organic acid) had the lowest crude protein and ether extract digestibility coefficients (0.78 and 0.79) respectively, which were improved ($P < .001$ and $P = .010$, respectively) by the addition of phytase + organic acid (0.89 and 0.86) respectively to the control diet. But in contrary, there were significant improvement in the digestibility of ether extract which was similar to the findings of [26], who reported that broilers fed the control diet had the lowest ether extract digestibility and were only improved by the addition of organic acid to the control diet. [27] also reported that addition of the microbial phytase enzyme and 3% citric acid to the broiler diet caused improvement in ileal nutrient (CP, AME, Ca and total P) digestibility and increased mineral retention of broiler chickens. This was similar to the digestibility of ash in birds in the present study.

Haematological parameters of broiler chicken fed antibiotics and organic salts supplemented diets

Haematological indices are an index and a reflection of the effects of dietary treatments on the animal in terms of the type, quality and amounts of the feed ingested that were available for the animal to meet its physiological, biochemical and metabolic necessities [28]. Haematological values also serve as baseline information for comparison in conditions of nutrient deficiency, physiology and health status of farm animals [29]. In this study, all the haematological indices measured were significantly influenced by the dietary treatments except basophils. Packed cell volume reference intervals were established for use in diagnosing anemia and polycythemia in young broiler chickens, a value below the minimum normal range is an indication of anaemia while there is an indication of dehydration when packed cell volume exceed the maximum normal range. The packed cell volume values were within the normal range (22% - 35%) reported by [30]. This implies that no anaemic condition occurred in the chicken. This result is not in agreement with the findings of [24] who reported that dietary organic acid supplementation had no effect on packed cell volume of broiler chickens.

Haemoglobin (Hb) has a protein in red blood cells which carries oxygen from the lungs to the body's tissues and returns carbon dioxide from the tissues back to the lungs. A low haemoglobin level is referred to as anaemia while dehydration produces highly haemoglobin measurement. In the results obtained from this study there was a significant difference among the treatments in blood haemoglobin levels and the values were within the normal range. This implies that antibiotics and organic acids supplementation probably had no deleterious effect on the broilers [31].

The red blood cell concentration reported in the study, for broiler chickens were within the normal range (2.5 – 3.5 x10^6µL) reported by [30] and showed no anaemic condition among the treatment groups except for sodium acetate supplemented diet which was higher than the normal range,. This result implies that supplementation of organic acids has no deleterious effect on the broiler chickens as they maintain their normal body counts and this also agrees with the findings of [31].

Table 4: Serum biochemical indices of broiler chicken fed antibiotics and organic salts supplemented diets (0-21days)

	Treatments					
Parameters	**Negative control (basal diet)**	**Positive control (antibiotic diet)**	**Negative control+ Sodium acetate**	**Negative control+ Sodium propionate**	**Negative control+ Sodium acetate+ Sodium propionate**	**P-Value**
Total protein (g/dL)	4.59 ± 0.48^{b}	5.86 ± 0.18^{a}	3.38 ± 0.23^{c}	4.10 ± 0.47^{b}	3.93 ± 0.53^{bc}	0.0001
Albumin (g/dL)	1.79 ± 0.16^{b}	2.38 ± 0.36^{a}	2.01 ± 0.33^{ab}	2.00 ± 0.02^{ab}	1.83 ± 0.24^{b}	0.0044
Creatinine (mg/dL)	0.88 ± 0.17	0.88 ± 0.15	0.88 ± 0.08	0.97 ± 0.16	0.89 ± 0.07	0.7528
Urea (mg/dL)	2.85 ± 0.36	3.73 ± 0.50	3.91 ± 0.74	3.55 ± 0.53	3.65 ± 0.88	0.0685
Calcium (mg/dL)	21.29 ± 0.65^{a}	18.32 ± 2.18^{b}	15.85 ± 1.69^{c}	10.91 ± 0.89^{d}	12.45 ± 1.03^{d}	0.0001
Phosphorus (mg/dL)	5.17 ± 1.25^{b}	6.50 ± 0.72^{b}	5.37 ± 0.78^{b}	8.77 ± 0.64^{a}	8.98 ± 0.52^{a}	0.0001
Alanine amino transferase (I.U/L)	2.54 ± 0.36^{b}	2.46 ± 0.08^{bc}	1.93 ± 0.01^{cd}	1.91 ± 0.03^{d}	3.65 ± 0.60^{a}	0.0001
Aspartate amino transferase (I.U/L)	54.93 ± 7.76^{a}	40.30 ± 2.73^{c}	44.67 ± 5.60^{bc}	48.50 ± 2.20^{ab}	51.53 ± 3.09^{ab}	0.0002

^{abcd}Means with same alphabetical superscripts are not significantly different (p>0.05).

White blood cells are the cells of immune system that are involved in protecting body against both infectious disease and foreign invaders. A significant increase in white blood cells was observed in all treatments except for antibiotic and sodium acetate supplemented diets which showed a significant decrease compared to basal diet, sodium propionate and the combination respectively. This probably indicated that microbial interactions and effects on local immune stimulation resulted in increase of white blood cells and boosted immunity. The results from this study is in accordance with findings of [32, 33] who reported that a significant decrease in the number of white blood cell counts in antibiotics fed birds when compared to organic acid supplemented diet in broiler chicken. Moreover, [34] noted that dietary inclusion of benzoic acid did not affect the white blood cell counts and differential leucocytic count of broilers at days 21 and 42 of life. Results from the study showed significant differences in all the leucocyte differential counts except basophils. This was at variance with the findings of [35] who reported no significant difference in the leucocyte differential counts of birds on experimental diets. The authors averred that it was an indication that the birds were not stressed during the experiment by nutritional or environmental factors, since leucocyte responses are considered as better indicators of chronic stress.

Serum biochemical indices of broiler chicken fed antibiotics and organic salts supplemented diets

Serum biochemical analysis is used for detection of organ diseases in domestic mammals and to evaluate protein quality and amino acid requirements in animals as reported

by [36]. From the study, serum total protein concentrations for broiler chickens were within the normal range (2.5- 4.5 g/dL) reported by [37] except for basal diet and antibiotic group which showed higher values of total protein than the normal range, this implies that the birds had less protein demand to the tissues and it disagrees with the reports of [34], who recorded a significant decrease in total protein in birds fed with 0.2% benzoic acid. [14] reported that there was improved immune response when albumin values across the dietary treatments fell within the standard range for chickens and this agrees with the results of this study. [38] found no significant effect on serum creatinine and urea in broiler chickens fed on organic acids. [3] also reported that blood serum parameters, including creatinine, triglyceride and total cholesterol were unaffected significantly by feeding diets containing acidifiers. These were similar to the findings of the present study as dietary treatments had no influence on the serum urea and creatinine of birds on treatment groups.

It was found [39, 40] that ~~the~~ acidic anion complex with phosphorus, magnesium and zinc, which results in an improved digestibility of these minerals. [41] observed an increase in blood calcium of broiler chicks fed on dietary acidifier. This did not agree with the results from the study, where birds on basal diet had the highest calcium level when compared to the other treatments. The increase of phosphorus levels in blood serum produced by addition of organic acids may be attributed to the lowering of GIT pH by using these acids, which increases the absorption of such minerals from the gut into the blood stream. Improving the utilisation of calcium and phosphorus by organic acids supplementation was revealed by [42]. Serum alanine amino transferase (ALT) and aspartate amino transferase (AST) biochemical indices test are done to identify liver disease in the body system. Therefore, increase in the ALT and AST levels in blood are mostly caused by liver damage [43]. The results from this present study, showed that birds on basal diet had significantly higher ALT and AST values when compared to antibiotics and organic acids supplemented diets. [40] demonstrated that the level of AST was reduced in growing rabbits fed supplemental citric acids although ALT was not significantly affected.

Conclusion and Applications

1. The present study showed that sodium acetate, sodium propionate and their combination can replace antibiotic in broiler nutrition for improved production irrespective of type and level of organic salts used.
2. Organic salts had positive effect on apparent nutrient digestibility and blood metabolites of broiler starter chickens
3. Inclusion level of 0.4% sodium acetate + 0.4% sodium propionate combination is recommended for broiler chicken at starter phase for improved nutrient digestibility and health status of birds.

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