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GROWTH PERFORMANCE OF BROILER CHICKENS FED DIETS SUPPLEMENTED WITH BLENDS OF ORGANIC ACIDS

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Abstract

Performance of broiler chickens fed diets supplemented with blends of organic acids was investigated. Three hundred broiler chickens were assigned to five treatment groups, each replicated three times with twenty birds per replicate in a completely randomized design. The chickens in the control treatment were fed the basal diet while all other treatments were fed acidified diets. Four blends of organic acids (Fysal®, Biotronic®, Orgacid® andAcidomix®) were supplemented in the diets of birds in treatments two to five, respectively at the manufacturers recommended level of 0.01%. Results indicated that all treatments fed acidified diets showed significantly ($P<0.05$) better performance in weight gain, feed to gain ratio and other productive parameters compared to chickens fed the control diet. It was concluded that broiler chickens can be supplemented withFysal®, Biotronic®, Orgacid® orAcidomix® at 0.01% inclusion level in their diets at both starter and finisher phases for improved performance.

Keywords: Feed, Organic acid, phytate,utilization

Introduction

Phosphorus (P) is an essential mineral for growth and skeletal development in chickens. Its deficiency results in deleterious effects such as skeletal deformities, impaired metabolic processes, poor nutrient utilization and decreased performance (Scott *et al*., 1982). Phytate can form complexes with proteins, starch, vitamins, minerals and other nutrients resulting in anti-nutritional effect as reported by Catalá-gregori*et al.* (2006). The binding effect of phytate on feed nutrients can result in poor weight gain, feed conversion ratio and other productive parameters in broiler chickens (Scott *et al*., 1982). The ability of poultry and pigs to breakdown phytate is poor due to insufficient intestinal phytase secretion (NRC, 1994). As a result, large amount of phosphorus and other nutrients are excreted in faeces causing environmental hazard, surface run-off, leaching and contamination of ground water (Paik, 2003). This has a detrimental effect on fish and other aquatic life. It was reported by Paik (2003) that absorption of phytate phosphorusby monogastric animals can beenhanced by removal of the phosphate groups from the inositol molecule.Thiscan be done by the use of phytase enzymes which have shown tremendous potentials in improving the utilization of phytate phosphorus by non-ruminant animals. To this effect, several studies have been conducted by some researchers (Ali, 2004; Otto *et al.,* 2011; Jalali and Babaei, 2012; Khalid *et al.*, 2013 and Shahzad*et al*., 2013).Their reports amongst a pool of others have shown promising results in the use of phytase enzymes to improve feed utilization and phytatephosphorus breakdown. Little attention has been paid to the use of organic acids in improving nutrient uptake by non-ruminant animals. Amongst other functions, organic acids primarily modify gut environment as well as prevent proliferation of non-beneficial micro-organisms in the gut of poultry birds. Apart from this primary function, organic acids have been reported to perform a secondary role which refers to their ability to form soluble complexes with minerals (Boling *et al*., 2000b).

Mineral chelators such as organic acids have been reported to compete favourably with phytate thereby forming soluble complexes with minerals and other nutrients in the lumen of the gut. This soluble complex is readily absorbed in the body and therefore enhances nutrient utilization. Cromwell (1992) asserted that the use of organic acids in diet of monogastric animals resulted in improved nutrient digestibility and growth performance. Citric, formic, fumaric, propionic, malic, butyric acidsand a few others have been found to be effective in improving post weaning performance in pigs (Risley*et al.,* 1992). It was reported by Rafacz-Livingston*et al.* (2005) that organic acids can also improve apparent nutrient digestibility in broiler chicks by lowering pH of the digesta in the small intestine thereby inhibiting the ability of phytate to form insoluble complexes that are resistant to hydrolysis by endogenous enzymes. Based on this premise, the study was carried out to determine the growth performance of broiler chickens fed diets supplemented with blends of organic acids.

Materials and Methods

Experimental site

The experiment was conducted at the livestock unit of the Department of Animal Science, Ahmadu Bello University, Samaru, Zaria. The livestock unit is located on latitude 11^0 9' 45'' N and 7^0 38' 8'' E at an altitude of 610m above sea level (Ovimaps, 2015).

Source of experimental birds

The birds used for the study were purchased from a commercial hatchery located in Ibadan, Oyo State, south western Nigeria.

Source of organic acids

Four commercial acidifiers i.e. Fysal®, Biotronic®, Orgacid®andAcidomix® containing different blends of organic acids were purchased from commercial feed outlets in Kaduna State.

Experimental diets

Five maize/soybean meal based broiler starter and finisher diets were formulated as shown in Tables 1 and 2, respectively. Treatment one was the basal diet without supplemental organic acids, while others were supplemented at the manufacturers recommended level of inclusion (0.01%).

Fysal®, Biotronic®, Orgacid®andAcidomix® were used as blends of organic acids. Fysal®contains sorbic, lactic, propionic, ascorbic and citric acid. Biotronic®containsformic, ammonium formate, propionic and ammonium propionate. Orgacid® contains formic, malic, tartaric, lactic and ortho-phosphoric acid. Acidomix® AFG contains formic, lactic, fumaric and ammonium formate. The broiler starter and finisher diets were formulated as follows; T_1 (basal diet), T_2 (basal diet + 0.01% Fysal®), T_3(basal diet + 0.01% Biotronic®), T_4 (basal diet + 0.01% Orgacid®) and T_5 (basal diet + 0.01% Acidomix®).

Experimental design and management of birds

Three hundred (300) day old broiler chicks were purchased for this study. They were brooded together for seven days, after which they were allotted to five experimental treatments. Each treatment was replicated three times with twenty (20) birds per replicate in a completely randomized design. At the end of the starter phase, broiler chicks in each replicate of their respective treatments were pooled together and fed a common dietfor one week. They were then assigned to five experimental treatments of eighteen (18) birds per replicate in a completely randomized design to commence the finisher phase. At both phases, the birds were raised on deep litter with feed and water provided *ad libitum*. All routine and management practices were strictly adhered to. Parameters measured were initial weight, final weight, weight gain, feed intake, and mortality records. Feed to gain ratio was calculated from feed intake and weight gain data, respectively.

Laboratory analysis

Proximate compositions of feed samples were determined at the Biochemical Laboratory, Department of Animal Science, A.B.U. Zaria using the methods of A.O.A.C. (1990)

Statistical analysis:

Data obtained from the experiment were subjected to analysis of variance using the General Linear Model Procedure of SAS (1993). Significant treatment means were separated using Duncan's Multiple Range Test.

Data obtained was analyzed using the following model.

$Y_{ij}= u + a_i + e_{ij}$

Where=

Y_{ij}= individual observation

u= overall mean

a_i= effect of the i^{th} organic acid on the feed (i= Fysal®, Biotronic®, Orgacid® and Acidomix®).

e_{ij}= random error

Results and Discussion

Starter phase

Performance of broiler chickens fed diets supplemented with blends of organic acids(1-5 weeks)

Table 3 shows the performance of broiler chickens fed diets supplemented with blends of organic acids. Broiler chicks fed diets supplemented with organic acids showed significantly (P<0.05) higher weight gain compared to chicks fed the basal diet. The improved performance in weight gain in all treatments supplemented with organic acids (T_2-T_5) as compared to the control

(T_1)supports the assertion that organic acids form soluble complexes with proteins, starch, vitamins and minerals thereby leading to improved nutrient uptake and utilization. The increased weight gain observed in all treatments fed acidified diets was an indication that organic acids improved nutrient utilization by reducing the ability of phytate to form complex with feed nutrients. Phytate has been reported by Catalá-gregori *et al.*, (2006) to form insoluble complexes with protein, starch, minerals and vitamins, thereby affecting weight gain and other productive parameters. Bozkurt *et al.* (2009) reported increased body weight gain with broiler chicks due to increased phytic acid hydrolysis when diets were supplemented with acidifiers. Similarly, Boling, *et al.* (2000b) observed improved weight gain and tibia ash of broiler chicks and pigs fed diets supplemented with citric acid. The highest feed intake was observed in all treatment groups fed acidified diets as they had values that were comparable (P>0.05) to each other, but significantly (P<0.05) higher than the control. The increased feed intake observed in all treatments supplemented with acidifiers compared to those fed control diet may have resulted from improved feed palatability as organic acids have been reported to enhance palatability and utilization of feed nutrients. This agrees with the assertions of Runho *et al*., (1997) and Garcia *et al*.(2007)who observed significantly higher feed intake when broiler chicks were fed acidified diets. Feed conversion ratio and feed cost per kilogram diet did not show significant (P>0.05) difference across all treatments. However, the slight improvement in feed conversion ratio across all treatments supplemented with organic acids was attributed to better feed utilization.

Chicks fed the control diet and chicks fed diets supplemented with Acidomix® showed the poorest (P<0.05) results in feed cost per kilogram weight gain. The best (P<0.05) results were obtained in treatments supplemented with Fysal®, Biotronic®and Orgacid®. Feed cost per kilogram weight gain was least and significantly (P<0.05) better for chicks fed diets supplemented with Fysal®, Biotronic® and Orgacid®due to values obtained in feed conversion ratio. The non-significant (P>0.05) but poorer values obtained in feed conversion ratio for chicks fed Acidomix®and the control diet resulted in the poor performance in feed cost per kilogram weight gain. Mortality records showed that chicks fed the control diet and diet supplemented with Fysal® had the least (P<0.05) mortality while chicks fed diets supplemented with Biotronic®, Orgacid®and Acidomix®showed significantly (P<0.05) higher mortality. The significant difference (P<0.05) observed in percentage mortality across all treatments groups was not attributed to supplemental organic acids as the acidifiers were included at the manufacturer's recommended levels of inclusion and postmortem results showed that few chicks were infected with coccidiosis.

Finisher phase

Table 4 shows the performance of broiler chickens fed diets supplemented with blends of organic acids. Broiler chickens fed diets supplemented with Fysal® showed the highest (P<0.05) weight gain compared to all other treatments. The highest weight gain observed for chickens fed diets supplemented with Fysal®was attributed to citric acid being a constituent of the blends of organic acids in Fysal®. Rafacz-Livingston *et al.*, (2005) reported that organic acids containing citric acid are effective in phytate phosphorus utilization and nutrient retention because, citric acid potentially chelates or bind with phytates in the lumen of the gut forming soluble complexes that are metabolizable, thereby preventing the formation of insoluble phytate complexes. Liem *et al*., (2008) also suggested that citric acid was the most effective of the organic acids used in his study. Broiler chickens in other treatments fed diets supplemented with Biotronic®, Orgacid®and Acidomix®had similar values ($P>0.05$) in weight gain which were significantly ($P<0.05$) better than the control treatment. Reports of previous studies (Boling *et al*. 2000a; Boling *et al*., 2000b; Rafacz-Livingston *et al.* 2005;Liem *et al*. 2008 and Ghazalah *et al*. 2011) amongst others are in tandem with the result obtained in weight gain in this study. Their results showed that dietary supplementation with organic acids improved feed palatability and nutrient utilization. Feed intake and feed conversion ratio across all treatments fed acidified diets did not differ significantly ($P>0.05$) from each other, but were significantly better ($P<0.05$) than the control. The increased feed intake in all treatments fed diets supplemented with organic acids was an indication of better feed palatability with feed acidification.

The poorest result obtained in feed conversion ratio observed for birds fed the control diet was an indication that feed utilization was poor as phytic acid has been reported to bind feed nutrients making them unavailable. Runho *et al*., (1997) and Garcia *et al*., (2007) observed significant improvement in feed conversion ratio of broiler finisher chickens fed diets supplemented with organic acids. More recently was the assertion of Vijaya and Shyam (2013) who observed better feed conversion ratio of broiler chickens fed diets supplemented with organic acids compared to the control treatment. Feed cost per kilogram weight gain was significantly ($P<0.05$) lower in treatments fed diets supplemented with Fysal®and Biotronic®compared to all other treatments. Feed cost per kilogram weight gain was best for broiler chickens fed diets supplemented with Fysal®and Biotronic® thus, showing better feed utilization in both treatment groups. Results of postmortem showed that mortality was not due to acidifiers but a resurgence of coccidiosis.

Conclusion

The study concluded that broiler chickens can be supplemented withFysal®, Biotronic®, Orgacid® orAcidomix® at 0.01% inclusion level in their diets at both starter and finisher phases for improved performance.

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Feed composition Tables:

Table 1: Composition of Experimental Broiler Diets Supplemented with Different Blends of Organic Acid (1-5weeks)

Parameters	Control	Fysal®	Biotronic®	Orgacid®	Acidomix®
Maize	56.0	56.0	56.0	56.0	56.0
Soyabean cake	24.0	21.0	21.0	21.0	21.0
Groundnut cake	14.0	14.0	14.0	14.0	14.0
Maize offal	2.0	2.0	2.0	2.0	2.0
Limestone	1.0	1.0	1.0	1.0	1.0
Bone meal	3.0	3.0	3.0	3.0	3.0
Common salt	0.3	0.3	0.3	0.3	0.3
Vitamin premix*	0.3	0.3	0.3	0.3	0.3
Lysine	0.2	0.3	0.3	0.3	0.3
Methionine	0.2	0.2	0.2	0.2	0.2
Organic acid	-	0.01	0.01	0.01	0.01
Calculated analysis	100.0	100.0	100.0	100.0	100.0
ME (Kcal/kg)	2894	2894	2894	2894	2894
Crude protein (%)	22.28	22.28	22.28	22.28	22.28
Ether extract (%)	4.66	4.66	4.66	4.66	4.66
Crude fibre (%)	4.27	4.27	4.27	4.27	4.27
Calcium (%)	1.22	1.22	1.22	1.22	1.22
Av. Phos. (%)	0.52	0.52	0.52	0.52	0.52
Lysine (%)	1.24	1.24	1.24	1.24	1.24
Methionine (%)	0.60	0.60	0.60	0.60	0.60
Cost/kg diet (₦)	70.00	71.00	71.00	71.00	71.00

*Biomix chick premix provide per kg of diet vit A, 10,000 i.u; vit D3, 2000 i.u; vit. E 23mg; vit K, 2.mg; calcium pantothenate, 7.5mg; B12, 0.015mg; folic acid, 0.75mg; choline chloride, 300mg; vit B1, 1.8mg; vit B2, 5mg; vit B6, 3mg; manganese, 40mg; iron, 20mg; zinc, 53.34mg; copper, 3mg; iodine, 1mg; cobalt, 0.2mg; selenium, 0.2mg; zinc, 30mg

Table 2: Composition of Experimental Broiler Diets Supplemented with Different Blends of Organic Acid (6-9weeks)

Parameters	Control	Fysal®	Biotronic®	Orgacid®	Acidomix®
Maize	60.0	60.0	60.0	60.0	60.0
Soya cake	20.0	20.0	20.0	20.0	20.0
Groundnut cake	16.0	16.0	16.0	16.0	16.0
Limestone	0.5	0.5	0.5	0.5	0.5
Bone meal	3.0	3.0	3.0	3.0	3.0
Common salt	0.3	0.3	0.3	0.3	0.3
Vitamin premix*	0.3	0.3	0.3	0.3	0.3
Lysine	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2
Organic acid	-	0.01	0.01	0.01	0.01
Calculated analysis	100.0	100.0	100.0	100.0	100.0
ME (Kcal/kg)	2932	2932	2932	2932	2932
Crude protein (%)	21.00	21.00	21.00	21.00	21.00
Ether extract (%)	4.58	4.58	4.58	4.58	4.58
Crude fibre (%)	3.94	3.94	3.94	3.94	3.94
Calcium (%)	1.04	1.04	1.04	1.04	1.04
Av. Phos. (%)	0.51	0.51	0.51	0.51	0.51
Lysine (%)	1.16	1.16	1.16	1.16	1.16
Methionine (%)	0.58	0.58	0.58	0.58	0.58
Cost/kg diet (₦)	71.00	72.00	72.00	72.00	72.00

*Biomix chick premix provide per kg of diet vit A, 10,000 i.u; vit D3, 2000 i.u; vit. E 23mg; vit K, 2.mg; calcium pantothenate, 7.5mg; B12, 0.015mg; folic acid, 0.75mg; choline chloride, 300mg; vit B1, 1.8mg; vit B2, 5mg; vit B6, 3mg; manganese, 40mg; iron, 20mg; zinc, 53.34mg; copper, 3mg; iodine, 1mg; cobalt, 0.2mg; selenium, 0.2mg; zinc, 30mg

Table 3: Effect of Blends of Organic Acid on Phytate Phosphorus Utilization by Broiler Chickens Fed Sub-Optimal Phosphorus Diets (1-5weeks)

			Acidifiers			
Parameters	Control	Fysal®	Biotronic®	Orgacid®	Acidomix®	SEM
Initial weight (g/b)	65.10	65.20	65.10	65.10	65.20	0.07
Final weight (g/b)	370.40^{b}	419.30^{a}	422.93^{a}	416.30^{a}	397.40^{a}	12.72
Weight gain (g/b)	305.30^{c}	354.10^{a}	357.83^{a}	351.20^{a}	332.20^{b}	4.84
Feed intake (g/b)	530.04^{b}	557.20^{a}	548.52^{a}	556.08^{a}	546.84^{a}	4.73
FCR	1.74	1.58	1.53	1.58	1.65	0.15
Cost/kg Diet (N)	70.56	72.07	71.20	72.00	72.34	0.72
Feed cost/kg gain(N)	122.77^{b}	113.87^{a}	108.94^{a}	113.76^{a}	119.36^{b}	3.78
Mortality (%)	0.67^{a}	0.67^{a}	1.00^{b}	1.00^{b}	1.00^{b}	0.06

^{abc}Means with different superscript on the same row differed significantly ($P<0.05$), SEM= Standard Error of Mean

Table 4: Effect of Blends of Organic Acid on Phytate Phosphorus Utilization by Broiler Chickens Fed Sub-Optimal Phosphorus Diets (6-9weeks)

			Acidifiers			
Parameters	Control	Fysal®	Biotronic®	Orgacid®	Acidomix®	SEM
Initial weight (g/b)	510.03	510.23	510.17	510.20	510.17	0.07
Final weight (g/b)	1791.93^{c}	2082.02^{a}	1983.46^{b}	1948.45^{b}	1970.56^{b}	33.59
Weight gain (g/b)	1281.90^{c}	1571.79^{a}	1473.29^{b}	1438.25^{b}	1460.39^{b}	20.04
Feed intake (g/b)	3370.36^{b}	3424.68^{a}	3410.40^{a}	3422.16^{a}	3403.40^{a}	19.45
FCR	2.63^{b}	2.18^{a}	2.31^{a}	2.38^{a}	2.33^{a}	0.10
Cost/kg Diet (N)	79.42	82.15	80.10	82.25	84.15	2.27
Feed cost/kg gain(N)	208.87^{c}	179.09^{a}	185.03^{a}	195.76^{b}	196.07^{b}	4.89
Mortality (%)	0.67^{a}	1.00^{a}	0.33^{a}	2.67^{b}	0.67^{a}	0.27

^{abc}Means with different superscript on the same row differed significantly ($P<0.05$), SEM= Standard Error of Mean