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Lime (*Citrus aurantifolia*) As a Source of Organic Acids on Growth Performance and Carcass Traits of Broiler Chickens

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Abstract
The experiment was conducted to determine the effect of lime (juice and whole fruit) on performance and carcass characteristic of broiler chickens. 150 day-old broilers of Anak 2000 strain, were used in a completely randomized design (CRD), with each group having 30 birds, replicated three times to give 10 birds per replicate. Five treatments were applied with treatment 1 as control; treatment 2, had 5ml of lime juice per litre of water every day; treatment 3, had 7.5g of whole lime fruit per litre of water every day; treatment 4, had 5ml of lime juice per litre of water in alternate days; treatment 5, had 7.5g of whole lime fruit per litre of water in alternate days. The treatments were applied for 4 weeks of the bird finishing phase. The result for growth performance revealed that there were significant differences in average final weight, weight gain and feed conversion ratio. Treatment 4 had better weight gain and feed conversion ratio (1.60kg/bird and 2.56 respectively), as against the control that had the least (0.96kg/bird and 4.19 respectively). Results from carcass characteristics and internal organs traits also showed varied significant differences in some parameters. Abdominal fat was least in treatment 5 with 18g as against the control with 41.00g. These results show that the inclusion of lime as juice and as whole fruit, improved the productive parameters assessed in comparison to the control and thus possess considerable potential as an alternative to antibiotics growth promoters.

Keywords: broiler chickens, lime fruit, non-antibiotic growth promoter, growth performance, carcass traits

Introduction

The use of antibiotics in animal nutrition, as antimicrobial growth promoters (AGP), has been without doubt beneficial for the improvement of zoo technical performance parameters and prevention of diseases. However, bio-security threats for human and animal health, arising from the escalating resistance of pathogens to antibiotics and the accumulation of antibiotic residues in animal products and the environment call for a worldwide removal of AGP from animal diets (Burt, 2004). The European Union has pioneered the complete ban of all AGP since January 2006. As a result, the demand for alternative products to antibiotics that can be used as prophylactic and as growth promoting agents is very high. In this sense, the highly intensive broiler production sector of the poultry industry takes a lot of interest to optimize performance and minimize economic losses as a result of AGP removal, whilst ensuring the safety of broiler meat via the control and/or elimination of food borne pathogens (Mountzouris, *et al*., 2008).

Organic acids, organic minerals, bacteriophages, probiotics, and prebiotics have been suggested as a useful dietary means for compensating the loss in productive performance when AGPs are removed from poultry diets (Yan *et al.*, 2012). Among these alternatives, dietary organic acids such as formic, citric, ascorbic, acetic, butyric acids etc have gained great attention because of their antimicrobial activity against pathogenic bacteria and the fact that these compounds can induce a pH reduction in the gastrointestinal tract (GIT), which can improve nutrient utilization in poultry diets (Kil,*et al.*, 2011).

Short chain fatty acids such as formic, acetic, propionic, and butyric acid, and other carboxylic acids such as lactic, malic, tartaric, fumaric, and citric acid have been most commonly used in the poultry industry because their chemical and physical properties are applicable to poultry diets (Dibner and Buttin, 2002).Commercial organic acids currently in use are synthetic types which are expensive and in most cases not readily available to local farmers. Also going by the campaign in favour of organic farming or use of natural additives in meat animal feeds, it is important to survey the natural ecosystem to discover and exploit some natural sources of organic acids.

Lime, a citrus *spp* which abounds in tropical ecosystem is a rich source of citric and ascorbic acids (Penniston *et al*., 2008) can serve this purpose. Lime fruits are classified as acid fruits, since their soluble solids are composed mainly of organic acids and sugars. Themain acids of lime fruits are citric and malic acids with trace amounts of tartaric, benzoic, oxalic and succinic acids (Karadeniz, 2004).

Materials and Methods

The experiment was conducted at the Poultry unit of the Teaching and Research Farm, Ambrose Alli University, Ekpoma, Edo State, Nigeria. The lime fruits were purchased from the local market in Ekpoma. The good fruits were washed with clean water and divided into two sets. The first set was immersed in hot water for about five minutes, so as to ease the juice extraction. They were thereafter cut into two halves with a sharp knife and the juice expelled manually by squeezing. The extracted juice containing the seeds was passed through a filter material to remove the seeds. The second set of fruits were diced whole and soaked in warm water overnight prior to use the following day.

Completely randomized design (CRD) was employed. One hundred and fifty (150) day-old unsexed broiler chicks of Anak2000 strain were used for this study. The chicks were randomly divided into five treatments, with 30 birds per treatment group. Each treatment was replicated three times to give 10 chicks per replicate. T1 was the control containing neither lime juice nor diced whole lime fruit. Treatment 2 was offered 5ml of lime juice per liter of drinking water every day. Treatment 3 was offered 7.5g diced whole lime fruit per litre of water every day. Treatment 4 was offered5ml lime juice per litre of water in alternate day, while treatment 5 was offered 7.5g of diced whole fruit per litre of drinking water in alternate day.

The brooding pen and its environment was thoroughly cleaned, washed with detergent and disinfected. The birds were brooded for 4 weeks after which they were moved to the experimental pen at the beginning of the fifth week, till the eighth week when the experiment was terminated. Feed and water was offered *ad libitum* throughout the duration of the experiment. Commercial starter and finisher feeds purchased from a local feed vendor were offered to the birds.

Feed intake, weight gain and feed conversion ratio were assessed on a weekly basis. Feed intake was determined by weighing the quantity of feed offered weekly and subtracting the left over at the end of the week. Average feed intake and average daily feed intake were calculated from the recorded data. At the end of the feeding trial, three finisher broilers with mean body weights close to the treatment average was selected from each treatment and used for carcass traits analysis.

All data was collected and subjected to a one-way analysis of variance (ANOVA) by using the general linear model procedure of SAS (2012) and differences in means was compared by Duncan's multiple range tests as outlined by Steel and Torrie (1980).

Results and discussion

The measured and estimated performance characteristics of the experimental birds are as stated in table 1.Significant differences were recorded in the final weight, average weight gain and average daily weight gain. Average final weight was highest in treatment 4 (5ml of lime juice per litre of water in alternate days) with 2.70kg/birds while the control diet (treatment 1) had the least final weight of 2.13kg/birds. For average weight gain Treatment 4 had the highest value of 1.6kg/per bird, followed by treatment 2, 3 and 5, with 1.57, 1.56 and 1.20kg per bird respectively. The least average weight gain was estimated in the control diet with 0.96kg/bird. Average daily weight gain followed same pattern of significance as the average weight gain followed similar pattern.

Table 1: performance characteristics of experimental birds

Performance characteristics	T1	T2	T3	T4	T5	SEM
Average initial weight (kg)	1.17	1.00	1.07	1.10	1.13	0.04NS
Average final weight (kg)	2.13^{c}	2.57^{b}	2.63^{ab}	2.70^{a}	2.33^{bc}	0.12*
Average weight gain (kg)	0.96^{c}	1.57^{ab}	1.56^{ab}	1.60^{a}	1.20^{bc}	0.11*
Average daily weight gain (g)	34.52^{c}	55.95^{ab}	55.71^{ab}	57.14^{a}	42.86^{bc}	4.03*
Average feed intake (kg)	4.02	4.11	4.01	4.10	4.06	0.04NS
Average daily feed intake (g)	143.57	146.79	143.21	146.43	145.00	1.60NS
Feed conversion ratio (FCR)	4.19^{b}	2.62^{a}	2.57^{a}	2.56^{a}	3.38^{ab}	0.32*

NS = Not significant; * = significant difference; SEM = standard error of mean
a,b,c: means along the same row with different superscripts are significantly different

Feed conversion ratio (FCR) showed significant differences between treatments. Treatment 4 had a better performance with an FCR value of 2.56, while the least performance was estimated in the control treatment with the highest FCR value of 4.19. The result recorded in the present study is in agreement with that of Nagra *et al.* (2005). They reported significant differences in average final weight, average weight gain and

average daily weight gain in a study with lime juice supplementation in broiler diet. According to the finding of this study, there was no significant difference in feed intake between treatments. This is however contrary to the findings of Khan and Sardar (2005), who reported that supplementation of lime led to a significant improvement in feed consumption.

The result as shown in table 2 shows significant differences in weights of the neck, back and abdominal fat only. Significant differences were also observed in the internal organs such as the heart, gizzard (with and without content), and spleen. The weight of the spleen, ranged between 2.00g in treatment 1 to 5.00g in treatment 3. Abdominal fat harvested from the carcass was least in treatment 5 (18.00g) and highest in treatment 1 (41.00g).

These results are in agreement with the research of Ndelekwute *et al. (*2015), where significant effects were reported on parameters such as abdominal fat, back and neck. Particularly, the results in abdominal fat, is in accordance with the report that lime juice reduced abdominal fat in broilers (Ndelekwute *et al*. 2015) and body fat in human (Liu *et al.* 2012). Ndelekwute *et al.* (2015) also observed significant differences in spleen, gizzard and heart which were higher in treated groups than the control, which is also in agreement with this work. However, Islam *et al.* (2008), reported no significant difference in internal organ from a similar research.

Table 2: Carcass and internal organs characteristics of experimental birds

Parameters	T1	T2	T3	T4	T5	SEM
Live weight (kg)	2.10	2.70	2.90	2.90	2.50	0.19NS
Plucked weight (kg)	1.90	2.40	2.50	2.60	2.20	0.17NS
Eviscerated weight (kg)	1.60	2.10	2.20	2.30	1.90	0.18NS
Head (g)	62.00	67.00	64.00	74.00	65.00	5.43NS
Neck (g)	124.00^{b}	158.00^{a}	149.00^{a}	158.00^{a}	139.00^{ab}	7.87*
Breast (g)	381.00	573.00	689.00	587.00	463.00	76.18NS
Back (g)	238.00^{c}	292.00^{abc}	310.00^{ab}	353.00^{a}	285.00^{bc}	18.70*
Thighs (g)	281.00	353.00	358.00	379.00	276.00	33.23NS
Drum sticks (g)	230.00	292.00	279.00	304.00	231.00	24.06NS
Shanks (g)	90.00	111.00	101.00	124.00	105.00	9.79NS
Wings (g)	210.00	258.00	271.00	288.00	243.00	16.24NS
Heart (g)	10.00^{b}	11.00^{b}	12.00^{b}	16.00^{a}	16.00^{a}	0.95*
Gizzard (WC) (g)	54.00^{d}	68.00^{c}	75.00^{b}	70.00^{bc}	82.00^{a}	2.03*
Gizzard (WOC) (g)	43.00^{b}	55.00^{a}	58.00^{a}	56.00^{a}	61.00^{a}	2.29*
Spleen (g)	2.00^{b}	3.00^{b}	5.00^{a}	3.00^{b}	3.00^{b}	0.51*
Lungs (g)	17.00	18.00	18.00	17.00	16.00	1.05NS
Liver (g)	37.00	48.00	43.00	51.00	49.00	3.49NS
Intestine (g)	136.00	146.00	154.00	156.00	183.00	9.86NS
Abdominal fat (g)	41.00^{c}	28.00^{b}	21.00^{a}	27.00^{b}	18.00^{a}	3.23*

NS = Not significant; * = significant difference; WC = with content; WOC = without content; SEM = standard error of mean; a,b,c: means along the same row with different superscripts are significantly different

Conclusion

The results presented in this study has shown that the oral supplementation of lime juice and whole lime either everyday or in alternate days, generally improved performance and some carcass traits. Of particular interest is treatment 4 (5ml of lime juice per litre of water in alternate days) which gave better growth performance and some improved carcass trait than the control and the other treated groups. From the report above, it can be concluded that the oral supplementation of lime juice and whole lime had significant positive effect on broiler performance in comparison to the control. It therefore shows that it has great promise as an alternative to antibiotics growth promoters.

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