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Effect of Different Sources of Organic Acids on Growth of Starter Broiler Chicks

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Abstract
This experiment was conducted to determine the dietary effect of dry lime fruit (*Citrus latifolia*) pomace and a blend (1: 1) of synthetic organic acids (citric and ascorbic acids) on growth performance of starter broilers. One hundred and twenty (120) day old Hubbard chicks were used. There were 4 dietary treatments (T1, T2, T3, T4) replicated 3 times and each replicate had 10 birds. T1 was the control diet which had no lime fruit pomace, and citric acid and vitamin C blend. T2 contained 5% dry lime fruit pomace, T3 contained 0.5% of the organic acids blend and T4 contained 5% lime fruit pomace and 0.5% of the blend. The lime fruit pomace as well as the citric and ascorbic acids blend were incorporated into the feed formula. Feed and water were supplied *ad libitum* for 28 days the experiment lasted. The pomace contained 1.24% and 1.75% citric acid and ascorbic acid respectively. Results indicated organic acid blend improved live weight and feed intake, while feeding pomace alone and mixture of pomace and organic acids blend reduced final live weight. It is therefore recommended that the organic acids blend could be incorporated in diets for starter broiler chicks.

Introduction

Poultry rations are formulated to contain an optimum nutrient concentration obtainable at a reasonable cost for desirable productivity. These nutrients concentrations currently due to technology of feed formulation such as use of software can easily be achieved. The onus lies on the utilization of the feed by the animal. The animal factor is now a critical factor in nutrient utilization and the gut plays essential role. The gut should be healthy with vibrant and working architecture. For instance, it must have friendly micro flora such as Lactic acid bacterium, optimum number of villi with good height that are working. Also,the secretory, digestive and absorptive capacity of the gut should not be in doubt. In absence of these, feed utilization could be undermined irrespective of the quality of the feed. Recognising this, certain non-nutritive feed additives have been used for decades to achieve these. Feed additives have been widely used to increase the performance of animals and are now extensivelyused in poultry feeding (Khan *et al.*, 2007). They are used not only to stimulate the growth and feed efficiency but to improve the general performance of birds (Abouelfetouh *et al.* 2012).Several antibiotic growth promoters have been used in poultry feeding which aimed at preventing diseases, improving growth performanceand to increase useful micro-organisms in the intestine. However, because of residual effect, the use of antibiotic growth promoters as feed additives and find alternatives to them in poultry diets, researchers are now focusing on alternatives in place of antibiotics (Farthi *et al*., 2016). For this reason, alternative additives such as herbs, spices, essential oils (extracted from aromatic plants), enzymes, organic acids, prebiotics and probiotics are used as growth promoters in poultry diets in many countries for organic poultry production (Griggs and Jacob, 2005).

Organic acids have shown positive results in poultry production, for reducing the intestinal pH and bacterial growth thusproviding better intestinal health for birds to obtain maximum nutrient absorption (Mohammadagheri *et al.* (2016). Organic acids such as formic, citric, ascorbic, butyric and acetic acids can be found in fruits as well as ants. Such fruits include lime fruit and lime products such as the juice, peel and pomace. They are easily accessible by local farmers and rarely scarce as they are grown all-round the season, and cheap especially the by-products of the industry, such as the pomace.

The objective of this study was to determine the effect of dry lime fruit pomace as source of citric and ascorbic acids and their synthetic blend on performance of starter broiler chicks.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm of the University of Uyo ,Uyo, Akwalbom State, Nigeria. The lime fruits used were purchased from the market. They were thoroughly washed with water. Each fruit was cut into pieces and thereafter ground with grinding machine. Cheese cloth was used to extract the juice. The chaff (pomace) was then dried under the sun. The dried pomace was stored in a transparent plastic container. The ascorbic and citric acid content of the dry pomace was determined (Novella 2014). Starter broiler diets were formulated (Table 1).

The experiment was carried out in completely randomized design (CRD). One hundred and twenty (120) birds were used. There were four dietary treatments (T1, T2, T3 and T4) each having 30 birds. Each treatment was replicated three times and each replicate had 10 birds. T1 was the control diet without dry lime fruit pomace, citric/ascorbic acids; T2 contained 5 percent lime fruit pomace; T3 contained 0.5 percent citric/ascorbic acids blend; T4 contained 5 percent lime fruit pomace and 0.5% citric/ascorbic acids blend.

Data collected were subjected to Analysis of Variance (ANOVA). Where significant effects were detected from analysis of variance, treatment means were compared using Duncan's New Multiple Range test (Steel and Torrie, 1980).

Table 1: Ingredient and nutrient composition of experimental starter diets

	T1	T2	T3	T4
Ingredients (%)	Control	Pomace	Acids	Acids+Pomace
Maize	52.0	52.0	52.0	52.0
Soya bean meal	30.0	30.0	30.0	30.0
PKC	9.00	4.00	8.00	3.00
Fish meal	4.00	4.00	4.00	4.00
Bone ash	4.00	4.00	4.00	4.00
Pomace	-	5.00	-	5.00
Citric acid	-	-	0.50	0.50
Ascorbic acid	-	-	0.50	0.50
Salt (NaCl)	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20
Premix*	0.35	0.35	0.35	0.35
Total	100.00	100.00	100.00	100.00
Calculated nutrient content (%)				
CP	22.58	21.86	22.40	21.50
EE	4.05	3.88	4.01	3.69
CF	3.88	3.76	3.80	3.66
Kcal/kg ME	2890	2800	2865	2800

*Premix supplied per kg starter diet: vitamin A 15,000 i.u., vitamin D_3 13000 i.u, thiamine 2mg, riboflavin 6mg, pyridoxine 4mg, niacin 40mg, cobalamine 0.05g, biotin 0.08mg, choline chloride 0.05g, manganese 0.096g, Zinc 0.06g, iron 0.024g, copper 0.006g, iodine 0.014g, selenium 0.24mg, cobalt 0.024mg and antioxidant 0.125g.

Resultsand Discussion

The effects of citric, ascorbic acids blend and dry lime fruit pomace on growth performance is shown in Table 2. The organic acids blend and the dry lime fruit pomace significantly ($p<0.05$) influenced growth performance. Dry lime fruit pomace exerted negatively on the final live weight as the live weight of birds that consumed the pomace was the lowest compared to the control and the birds that consumed both 0.50% blend of crystalline ascorbic and citric acids. The negative effect on final live weight was more pronounced in birds that consumed the mixture of dry lime fruit pomace, 0.50% crystalline citric/ascorbic acids blends. Citric/ascorbic acid blend improved final live weight. While daily weight gain was improved by the organic acids blend, combination of the organic acids and the dry pomace significantly ($p<0.05$) reduced daily gain. There was no difference in daily weight gain between the control and dry pomace. In terms of feed intake both total and daily feed intakes were higher in the group that consumed organic acids blend compared to the control, dry pomace and mixture of dry pomace and organic acids blend. Feed: gain ratio was poor in group of birds that consumed mixture of dry pomace and organic acids blend compared to the control, dry pomace and organic acid blend. Feed: gain ratio was poorest in birds that consumed dry pomace and organic acids blend, but similar in control, organic acids blend and dry pomace. Protein intake followed similar trend as the feed intake. Control and dry pomace produced better protein efficiency ratio compare to organic acids blend and the mixture of dry pomace and acid blend.

Table 2: Effect of vitamin C, citric acid and dry lime fruit pomace on starter broilers

Treatments	T1	T2	T3	T4	
Parameters	Control	Pomace	Acids	Acids+Pomace	SEM
Initial live weight (g)	41.00	40.00	41.00	41.00	-
Final live weight (g)	748.0^{b}	696.0^{c}	812.0^{a}	626.0^{d}	26.06
Daily gain (g)	25.25^{b}	23.43^{b}	27.54^{a}	19.44^{c}	1.08
Total feed intake (g)	1324^{b}	1263^{b}	1510^{a}	1326^{b}	44.07
Daily feed intake (g)	47.29^{b}	45.11^{b}	53.93^{a}	47.36^{b}	3.21
Feed: gain ratio	1.87^{b}	1.93^{b}	1.96^{b}	2.44^{a}	0.18
Daily protein intake (g)	10.64^{b}	9.86^{b}	12.94^{a}	10.18^{b}	1.01
Protein efficiency ratio	2.26^{a}	2.38^{a}	2.13^{b}	1.91^{c}	0.16

[a,b,c,d]Means along the same row with different superscripts are significantly (P<0.05) different.

Generally, citrus fruits wastes contain essential bioactive compounds such as flavonoids and carotenoids which are known for their anti-oxidant properties exerting positive influence on health. Other known components such as organic acids and essential oils are known for their antibacterial actions and pectin for its gelation properties. The outcome of this work could be associated with biochemical composition of the test dry lime fruit pomace. The starter broilers which consumed dry pomace that recorded poor growth could probably be due to presence of pectin as reported by Silva *et al*. (2013). Pectin reduced nutrient digestibility especially protein and increased digesta viscosity thereby reducing transit time of digesta (Silva *et al.,* 2013).

High viscosity encourages fermentation, causes poor absorption of nutrients and could consequently lead to poor growth. Impressive performance of ascorbic and citric acids blend was in line with the report of Dibner (2004) that organic acids are good agents for growth promotion. This has been ascribed to the ability of organic acids to reduce the pH of proventriculusat early life of birds which is essential for adequate protein digestibility (Dibner, 2004; Ndelekwute *et al.,* 2015). Also the ability of organic acids to prevent early colonization of the gut by pathogenic bacteria and allows acid loving ones like lactic acid bacterium to thrive has also been linked to optimum performance of broilers (Choct, 2009). It was also observed that mixing the pomace with the blend of ascorbic and citric acids further reduced growth which could be opined to emanate from high level of ascorbic and citric acids. The dry pomace contained natural ascorbic and citric acids and mixing these acids with it could have increased its content of these organic acids.While citric and ascorbic acids are generally safe, side effects do occur if an excess of the acids is consumed. Some of these side effects include stomach cramps, diarrhea, nausea and vomiting (Acidpedia, 2017). The issue of stomach cramps means that the lining of the intestine could be eroded especially the villi thereby undermining the absorptive capacity of the duodenum.

Higher feed intake recorded by the ascorbic and citric acids blend was in line with characteristics of citric and ascorbic acids as reported by Lohakare *et al.* (2005) who attributed it to better nutrient digestibility. Organic acids improve gut health by reducing some biological reactions like fermentation which leads to digestion disorder. Hence, healthy gut could encourage and stimulate appetite. The results of feed intake, protein intake, feed: gain ratio and protein efficiency ratio clearly indicates that poor growth of the birds that consumed dry pomace mixed with organic acids blend could be due to poor utilization of nutrients.

Conclusion and Recommendation

Feeding of dry lime juice pomace and its combination with a blend of ascorbic and citric acids resulted to poor growth of broiler chicks. However, the organic acid blend improved live weight. It is therefore concluded that inclusion of 0.5% 1:1 blend of citric and ascorbic acids blend in diets for broiler chicks should be encouraged.

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