Carcass yield and internal organs of broiler chickens fed diets treated with organic acids

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Abstract

An experiment was conducted to determine the effect of different organic acids (OAs) on carcass yield and internal organ characteristics of broiler chickens. The OAs were acetic acid (AA) butyric acid (BA), citric acid (CA) and formic acid (FA). One hundred and fifty (150) day old AborAcre - plus chicks were used. There were five dietary treatments. Diet 1 which served as control (CON) contained no OA, while diets 2, 3, 4 and 5 respectively contained 0.25% AA, BA, CA and FA which replaced palm kernel cake in which each treatment was replicated three times with 10 birds per replicate and arranged in completely randomized design (CRD). Diets were both isoenergetic and isonitrogenous. The experiment lasted for 8 weeks. Feed and water were given ad libitum. At the end of the 8 weeks of feeding, 3 birds from each replicate giving a total of 9 birds per treatment were slaughtered for carcass and internal organ evaluation. Result from the carcass evaluation showed that there were no significant differences ($P>0.05$) in dressed carcass weight, thigh, wing and drumstick. All the OAs except BA produced bigger breast meat compared to the birds fed control diet. The weight of the backcut was significantly ($P<0.05$) reduced by FA compared to the birds on control diet. Birds that consumed FA treated diet deposited more abdominal fat and AA produced the least ($P<0.05$). Internal organ result indicated that both the liver and the kidney were not negatively affected by OA treated diets. Caecum and the large intestine were significantly larger in than those obtained from birds fed the control diet. Therefore, addition of the OAs except BA to broiler diets could be a good practice considering their positive effect on the breast meat which is a premium cut part.

Keywords: broiler chickens, carcass yield, internal organs, organic acids

Introduction

Broiler chickens are meat type of chickens that attain 2.0 kg live weight at eight weeks of age under good management practices (Obioha, 1992), genetic and environmental conditions (Sainsbury, 1980). In broiler production, faster growth is necessary if maximum productivity is to be achieved which would be reflected in the gross margin (Oluyemi and Roberts, 2000). To some extent, this could be achieved through provision of high quality feed and adequate quantity of the feed to meet the physiological and anatomical needs of the

birds. To achieve this, one of the nutritional strategies towards enhancing the rapid growth of broilers had been the addition of additives like the antibiotics to feed (Windisch, *et al.*, 2007).

Though the poultry farmer may optimize the growth of broilers through adoption of certain nutritional strategies such as application of feed additives, the live weight achieved should be replicated in the carcass yield. More also, in using feed additive the interest of the consumer mostly the meat quality should be considered. According to European Union Council on

Regulation of Feed Additives (EUC-RFA, 2003) feed additives should not impact negatively on animal products consumable by man. Consequently, recent concerns about the antibiotics resistance in livestock industry have indicated the need for alternative strategies to improve animal performance and health without the use of antibiotics (Chen *et al.*, 2005). Some dietary products are therefore being evaluated to replace antibiotics in poultry diets. These products include probiotics (Cheeson, 1994; Ziggers, 2009), prebiotic (Simmering and Blaut, 2001; Patterson and Burkholder, 2003; Gibson *et al.*, 2004),

yeast culture (Raju *et al.*, 2006; Banerjee, 2007; Gao *et al.*, 2008), essential oils and spices (Duke, 1994; Gwendolyn, 2002; Alciceck *et al.*, 2003; Windisch *et al.*, 2007) feed grade enzymes (Choct, 2007) and organic acids (Waldroup *et al.*, 1995; Leeson *et al.*, 2005; Ndelekwute *et al.*, 2010; Ndelekwute *et al.*, 2011).

Organic acids (carboxylic acids) have been used for decades in feed preservation, protecting feed from bacterial and fungal destruction (Paul *et al.*, 2007). Evidence of potentials of organic acids to support growth of broilers has been reported to be due to their antibacterial effect and

Table 1: Ingredients and Nutrients Composition of Starter Diets.

Ingredients (%)	CON	AA	BA	CA	FA
Maize	55.00	55.00	55.00	55.00	55.00
Soya bean meal	28.00	28.00	28.00	28.00	28.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm kernel cake	10.30	10.05	10.05	10.05	10.05
Bone meal	3.00	3.00	3.00	3.00	3.00
Organic acid	-	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Analyzed values (%)					
Crude protein	21.41	21.40	21.40	21.40	21.40
Energy (MJME/kg)**	11.85	11.84	11.84	11.84	11.84
Ether extract	3.62	3.62	3.62	3.62	3.62
Crude fibre	4.38	4.36	4.36	4.36	4.36
Ash	6.54	6.54	6.54	6.54	6.54
Calcium	1.11	1.11	1.11	1.11	1.11
Phosphorous	0.86	0.84	0.84	0.84	0.84
Lysine**	1.12	1.11	1.11	1.11	1.11
Methionine**	0.55	0.54	0.54	0.54	0.54

* premix supplied per kg starter diet: vitamin A 15,000 IU, vitamin D₃ 13000 iu, thiamin 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. CON = Control, AA = Acetic acid, BA = Butyric acid, CA = Citric acid, FA = Formic acid. ** Calculated.

stimulation of villi growth (Leeson *et al.*, 2005).

The objective of this study was to evaluate the effect of diets treated with organic acids (acetic, butyric, citric and formic acids) on the carcass yield and internal organ characteristics of broiler chickens.

Materials and Methods

Site of Experiment

The experiment was conducted at the Teaching and Research Farm of Department of Nutrition and Forage Science of the Michael Okpara University

of Agriculture Umudike; Abia State, Nigeria. Umudike is situated on latitude 5° 28'N and longitude 7° 32'E and lies at an altitude of 122 metres above sea level, with average rainfall of 2000 mm. The average relative humidity during the experiment was over 72% and average ambient temperature of 28°C.

Experimental Design

Completely randomized design (CRD) was used. One hundred and fifty (150) day old chicks of AborAcre-plus strain were used. There were divided into five treatments replicated three times with 10 birds per

Table: 2 Ingredients and Nutrients Composition of Finisher Diets.

Ingredients (%)	CON	AA	BA	CA	FA
Maize	55.00	55.00	55.00	55.00	55.00
Soya bean meal	25.00	25.00	25.00	25.00	25.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Palm kernel cake	14.30	14.05	14.05	14.05	14.05
Bone meal	3.00	3.00	3.00	3.00	3.00
Organic acid	-	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

Analyzed values (%)

Crude protein	19.85	19.84	19.84	19.84	19.84
Energy (MJME/kg)**	12.05	12.00	12.00	12.00	12.00
Ether extract	5.40	5.42	5.42	5.42	5.42
Crude fibre	5.60	5.58	5.58	5.58	5.58
Ash	6.30	6.31	6.31	6.31	6.31
Calcium	1.09	1.10	1.10	1.10	1.10
Phosphorous	0.80	0.72	0.72	0.72	0.72

Per kg finisher diet: vitamin 10, 0001.u., vitamin D₃ 12,0001.u. Vitamin E 201.U., Vitamin K 2.5mg, thiamine 2.0mg, Riboflavin 3.0mg, pyridoxine 4.0mg, Niacin 20mg, cobalamin 0.05mg, panthemic acid 5.0mg, Folic acid 0.5mg, Biotin 0.08mg, choline chloride 0.2mg, Manganese 0.006g, Zinc 0.03g, Copper 0.006g, Iodine 0.0014g, Selenium 0.24g, cobalt 0.25g and antioxidant 0.125g. CON = Control, AA = Acetic acid, BA = Butyric acid, CA = Citric acid, FA = Formic acid. ** Calculated.

replicate. Each treatment group received acetic acid, butyric acid, citric acid or formic acid at 0.25% level of their diet, while the control group received neither of the organic acids. Birds were fed the control diet for the first week of life. Organic acids were introduced during the second week and lasted for 7 weeks.

Experimental Diets

Five diets were formulated each for starter and finisher diets. The diets were isonitrogenous (21.40%) and isoenergetic (11.80 MJME/kg) for the starter diet table 1. 19.84% and 12.00 MJME/kg for the finisher diet (Table 2). The five diets contain the same proportion of feed ingredients except diets containing organic acids where 0.25% organic acids were added in each diet to replace palm kernel cake. Trial and error method according to Olomi (1995) was used to formulate the diets.

Management of Birds

At day old, the chicks were weighed, after which they were transferred into the brooding room. Glucose was added to their drinking water the first day to cushion the effect of stress induced due to long transportation and heat from the sun. From the second day, vitamin complex was added to their drinking water for five days. Feed and water were supplied *ad libitum*. They were stabilized for one week in the brooding room. Heat was supplied by kerosene stove placed under a hover. At the end of the one week stabilization period the birds were transferred to a rearing house, into a portion of the house that was covered with water proof material. Brooding continued to the third week of age.

At the end of the first week, they were randomly separated into treatment groups and weighed. Feeding of experimental diets started at the second week. The birds were vaccinated against Newcastle disease at day

old intraocularly and lasota at the 18th day through the drinking water. Infectious bursal (gumboro) disease vaccine was administered twice on the 10th and 17th day. The birds were fed formulated starter diet to the fourth week. At the end of the fourth week, they were fed finisher diet to the end of the experiment.

The birds were managed in a deep litter system using wood shavings as bedding materials in an open sided wire mesh building with zinc roof.

Carcass and Internal Organ Analysis

At the end of the feeding experiment, 15 birds, one from each replicate of a treatment were used for carcass analysis. The birds were fasted for 18 hours after weighing each bird. They were slaughtered by severing the throat with sharp knife and both the trachea and oesophagus were cut. To achieve complete bleeding, each slaughtered bird was hung with legs up till cessation of dropping of blood which lasted for 5 minutes. Hot water was used to defeather the birds by immersing in 60°C hot water for 30 seconds according to Mountney (1966) cited by Oluyemi and Roberts (2000). The loosed feathers were immediately plucked by hand.

After washing, the legs, head and the neck were cut and the crop gently removed. The abdomen was cut open and holding the gizzard the viscera was pulled out. The abdominal fat was removed. The wings were removed by cutting anteriorly, severing at the humero-scapula joint; the drumstick was cut at the tibio-tarso-metatarsus and humero-tibia joints; the thigh cutting was at the humero-tibia and humero-ilium joints. To separate the backcut (distance between the ileum and ischium) and the breast meat (distance between the sternum and the keel), a cut was made across the rib joints connecting them. Applying a gentle force, they were

separated from each other. Weight of the carcass parts, abdominal fat and internal organs were determined.

Dressed carcass weight, internal organs and abdominal fat were expressed as percentage live weight while weights of different cut carcass parts were expressed as percentage of dressed carcass weight according to Abaza *et al.* (2008). Carcass analysis was performed based on the procedure outlined by Scott *et al.* (1969)

Data Transformation and Statistical Analysis

Data collected which were expressed as percentages were transformed using Arc Sine as outlined by Preston (1996). All data were then subjected to analysis of variance (ANOVA). Significant means were separated using Duncan New Multiple Range Test according to Steel and Torrie (1980).

Results and Discussion

Experimental Diets

Tables 1 and 2 show the ingredient and nutrient composition of the experimental diets of starter and finishing phases. There were isonitrogenous and isoenergetic and conformed to the requirements of broilers raised in the tropical environment (NRC, 1994., Oluyemi and Roberts, 2000).

Carcass Weight

Table 3 shows the effect of organic acid - treated - diets on dressing percentage. There were no significant differences ($P>0.05$) in the dressing percentage of treated groups and the control. This is in contrast to Leeson *et al.* (2005) who reported that feeding of organic acids resulted to higher dressing percentage. Earlier, Kirkpiner *et al.* (1999) had reported in the contrary that the dressing percentage of birds fed diets treated with organic acid did not differ significantly from birds fed diet containing no organic acid.

However, within the organic acid groups, formic acid significantly produced higher dressing percentage than bird fed the butyric acid. Ndelekwute *et al.* (2010) reported that formic acid performed better than butyric acid in terms of muscle deposition. This is an indication that the formic acid diet was well utilized since carcass yield is an indication of the quality and utilization of diet (Isika, 2005) which was earlier reported to increase protein accretion (Maynard *et al.*, 1981).

For cut-up parts, weight of breast meat and backcut were significantly influenced, while those of thigh, wing and drumstick were not significantly affected. Breast weight was significantly higher in birds fed

Table 3: Effect of Organic Acid Treated Diets on: Carcass Yield of Broilers

Parameters %	CON	AA	BA	CA	FA	SEM
Slaughtered weight (g)	1715.41	1713.65	1643.16	1787.55	1772.07	
Dressed carcass	62.22 ^{ab}	62.44 ^{ab}	60.96 ^b	63.29 ^{ab}	64.67 ^a	0.7
Breast weight	30.23 ^c	31.56 ^b	30.32 ^c	31.84 ^b	32.59 ^a	0.13
Backcut	24.03 ^a	22.08 ^{ab}	22.66 ^{ab}	22.68 ^{ab}	20.85 ^b	0.17
Wing	12.09	12.21	12.61	12.30	12.59	0.52
Thigh	18.96	18.78	19.17	18.46	17.90	1.98
Drumstick	14.71	15.15	15.09	14.70	14.80	1.23
Abdominal fat	0.92 ^b	0.51 ^c	0.91 ^b	0.95 ^b	1.34 ^a	0.05

abc means along the same row with different superscripts are significantly different ($P<0.05$)

SEM = Standard error of mean. CON = Control, AA = Acetic acid, BA = Butyric acid, CA = Citric acid, FA = Formic acid.

diets containing acetic, citric and formic acid than in control. This result was in line with Lesson *et al.* (2005) who made similar observation. This is indicative that such organic acids could be used to improve breast meat which is a premium part of the carcass. The backcut of all the organic acids except formic acid were statistically the same with that of the control. The backcut of formic acid treated group was less than the control group ($P<0.05$). There was no significant difference in backcut within the organic acid groups thus confirming the result of Lesson *et al.* (2005).

Significant difference ($P<0.05$) was noted in abdominal fat. Birds that consumed diet treated with formic acid deposited more fat than the control and the other organic acids. Acetic acid group deposited the least amount of fat. The performance of formic acid group for fat deposition could be due to its ability to utilize energy efficiently as

reported by Ndelekwute *et al.* (2011) which could have led to excess to be stored as fat.

Weight of Internal Organs

The effect of diets on the internal organs of broiler chickens (Table 4) expressed in percentage indicates that there was significant effect ($P<0.05$) on crop, *proventriculus*, heart, spleen, *caecum* and large intestine. The birds fed control diet had the heaviest *caecum* and large intestine than all the organs obtained from birds fed organic acid. This could be due to activities of bacteria which was reported to colonize the gastrointestinal tract (Salanitro *et al.*, 1978; Vaughan *et al.*, 2000; Lu *et al.*, 2003; Sun, 2004). Fermentation activities of the microflora in the hindgut could lead to larger *caecum* and large intestine Choct (2009). The spleens of birds fed diets containing butyric and citric acids were significantly ($P<0.05$) larger than those fed control, acetic and formic acid diets.

Table 4: Effect of Organic Acid Treated Diets on Internal Organs of Broilers

Parameters (%)	CON	AA	BA	CA	FA	SEM
Slaughtered weight (g)	1715.41	1713.65	1643.16	1787.55	1772.07	
Crop	1.46 ^c	1.38 ^c	1.64 ^a	1.52 ^{ab}	1.49 ^{bc}	0.17
<i>Proventriculus</i>	0.51 ^{ab}	0.49 ^{ab}	0.57 ^a	0.52 ^{ab}	0.46 ^b	0.15
Gizzard	1.57	1.76	1.64	1.52	1.49	0.53
Liver	2.13	2.11	2.22	2.15	1.70	0.55
Heart	0.65 ^a	0.62 ^{ab}	0.52 ^c	0.56 ^{bc}	0.58 ^{abc}	0.13
<i>Pancreas</i>	0.30	0.29	0.29	0.31	0.28	0.12
Kidney	0.68	0.78	0.80	0.83	0.74	0.23
Lung	0.41	0.40	0.38	0.38	0.36	0.14
Spleen	0.09 ^b	0.09 ^b	1.40 ^a	1.40 ^a	0.10 ^b	0.04
Gall bladder	0.15	0.21	0.13	0.13	0.14	0.02
Small intestine	4.41	4.22	4.58	4.65	4.32	0.21
<i>Caecum</i>	1.94 ^a	1.51 ^b	1.43 ^b	1.40 ^b	1.22 ^b	0.45
Large intestine	0.93 ^a	0.62 ^b	0.61 ^b	0.59 ^b	0.54 ^b	0.07

abc means along the same row with different superscripts are significantly different ($P<0.05$)
SEM = Standard error of mean. CON = Control, AA = Acetic acid, BA = Butyric acid, CA = Citric acid, FA = Formic acid.

While the hearts of birds fed butyric and citric acid treated diets were smaller than those fed the control diet, the hearts of those fed acetic and formic acid treated diets were statistically the same with those fed the control diet. There were no significant differences in the *proventriculus* of those fed the control diet and those fed organic acid diets. But within the organic acid groups the *proventriculus* of those fed diet containing butyric acid was significantly larger than those fed formic acid diet. Weight of crop was significantly ($P<0.05$) larger in butyric and citric acids than the control.

The non significant effect of diets on the liver and kidney is an indication that the test organic acids did not influence negatively the two essential organs and hence did not negatively interfere with the biochemical functions of the organs. The liver plays an important role in protein metabolism while the kidney eliminates toxic materials such as ammonia from the body.

In conclusion, acetic, citric and formic acids could be used in broiler diets to produce higher percentage breast meat.

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