Effect of finisher diets treated with organic acids on carcass and internal organs of broiler chickens

E.K. [1]*Ndelekwute, K.U. [2] Amaefule, H.O. [3]Uzegbu, and C.O.[4] Okereke
[1]Department of Animal Science, University of Uyo, Uyo, Nigeria. [2]Department of Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike, Nigeria. [3]National Agricultural Extension Research Liaison Station, Ahmadu Bell University, Zaria, Nigeria. [4]Livestock Unit, Naational Root Crops Research Institute. Umudike, Abia State, Nigeria.
*Correspondence author: nekresearch@yahoo.com

Abstract

An experiment was carried out to determine the effect of different organic acids (OAs) on carcass yield and internal organ characteristics of broiler chickens. The OAs were ethanoic acid (acetic acid - AA), butanoic acid (butyric acid - BA), citric acid (CA) and methanoic acid (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 OAs, while 0.25% of AA, BA, CA and FA replaced palm kernel cake in diets 2 – 5. Each treatment was replicated three times with 10 birds per replicate, arranged in completely randomized design (CRD). Diets were both isoenergetic and isonitrogenous. The experiment lasted for 4 weeks during the finisher phase. Feed and water were given ad libitum. At the end of 4 weeks, 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 dressed carcass, breast, thigh, wing and drumstick of OA treated groups were not significantly (P>0.05) different from the control. The backcut was significantly (P<0.05) heavier in control than in AA and CA. Abdominal fat in birds fed OAs was statistically similar to the control. The liver weight was significantly (P<0.05) reduced by BA and FA while the weight of spleen was reduced (P<0.05) by all the OAs. The caecum and the large intestine were significantly (P<0.05) enlarged in the control. There was non effect (P>0.05) on other internal organs.

Keywords: broiler chickens, carcass yield, organic acids, internal organ characteristics.

Introduction

For years, animal nutritionists have adopted nutritional measures to improve the performance of broiler chickens even when adequate feed and feeding is assured. The performance of broilers is in most cases taken to be the growth which the farmer is interested on. To achieve faster growth at the shortest period some of the earlier measures adopted by nutritionists is to add growth promoters. Such growth promoting substances include Pharmaceutical antibiotics (Maynard *et al*., 1981; Ivanov, 2003).

However, because of problems posed by the use of pharmaceutical antibiotics in farm animals substances regarded as safe have been introduced (Bates *et al*., 1994; Sun 2004). Such substances 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) and feed grade enzymes (Choct, 2007). Recently, organic acids have been suggested to be included in broiler diets as growth promoter (Dibner, 2004; Leeson *et al*., 2005) because of their antibacterial action (Waldroup *et al*., 1995), protein digestion in young monogastrics (Makkink, 2001) and their positive influence on gut health generally (Debevere, 1987; Thaela, 1998). Nevertheless, it is necessary to know the impact of these additives on carcass and internal organs especially when fed only at the finisher phase. This is because feeding of organic acids such as citric and formic acids have been reported to improve growth when fed at starter phase (Ndelekwute *et al*., 2010) and digestibility (Ndelekwute *et al*., 2011).

Therefore, the objective of this research was to determine the effect of feeding broiler chickens diets treated with organic acids at the finisher phase on carcass yield and the internal organs of the 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^{o} 28^{1}N and longitude 7^{o} 32^{1}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^{oC}. This information was supplied by the meteorological unit of National Root Crop Research Institute, Umudike, Abia State Nigeria.

Source of Organic Acids

Organic acids (acetic, butyric, citric and formic acids) used in this study were obtained from a commercial dealer. They were manufactured in Great Britain by BDH Chemicals Ltd. with 99.50, 99.00, 98.50 and 98.00 % assay respectively.

Experimental Design

Completely randomized design (CRD) was used. One hundred and fifty (150) day old chicks of AborAcre-plus strain were used. Birds were divided into five treatment diets of three replicates per treatment of 10 birds per replicate. Each treatment group received acetic acid, butyric acid, citric acid or formic acid at 0.25% level of the diet, while the control group received neither of the organic acids. Birds were fed the control diet during the starter phase (1 – 4 weeks). Organic acids were then introduced at the finisher phase (5 – 8 weeks).

Experimental Diets.

Single starter diet (Table 1) without organic acid was formulated and fed to all the birds at the starter phase. At the finisher phase five diets were formulated which were isonitrogenous and isoenergetic. (Table 2). The five diets contained the same proportion of feed ingredients except the diets containing organic acids where 0.25% organic acid was added to replace the same proportion of palm kernel cake. Trial and error method according to Olomu (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 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*. Brooding heat was generated with kerosene stove placed under a galvanized metal hover. The birds were brooded for three weeks.

They were given NCDV vaccine (i/o) at day old, lasota on the 16th and 28th day. Infectious Bursal (Gumboro) disease vaccine was administered on the 11th and 18th day. Birds were also given Coccidiostat for 7 days from 15 – 21 day of age. by mixing in water amprolium (anticoccidial drug). Vitamin and mineral mix were given through the drinking water at intervals, especially before and after each vaccination. Feed and water were provided to birds *ad libitum.* The birds were fed starter diet not treated with organic acids (control diet) from the first to the fourth week. At the end of the fourth week, they were randomly separated into treatment groups in such away that they had similar average live weight. Feeding of organic acid treated finisher diets started at the fifth week and lasted till the end of the experiment.

The broilers were housed in a deep litter, open sided house roofed with corrugated iron sheets. The pens (1.5m x 1.2m) were demarcated with a concrete wall of 30cm high from the floor, while wire mesh ran from this height to 2m high. The building had a 1.2m high dwarf wall with the remaining space from the dwarf wall covered by wire mesh

Carcass and Internal Organ Analysis

At the end of the feeding experiment, 45 birds, three from each replicate of a treatment were used for carcass analysis. The birds were fasted for 18 hours. After weighing each bird, there were then slaughtered by severing the throat with a 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. Birds were immersed 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.

Removal of internal organs and cutting of carcass parts were done according to Scott *et al*. (1969) and Ndelekwute *et al* (2012). Dressed carcass weight, internal organs and abdominal fat were expressed as percentage live weight while weights of different cut-parts were expressed as percentage of dressed carcass weight according to Abaza *et al*. (2008).

Data Transformation and Statistical Analysis

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

Results and Discussion

Experimental Diets

Tables 1 and 2 show the ingredients and nutrient composition of the starter and finisher diets. Finisher diets were isonitrogeneous and isoenergetic and conformed to *the* requirements of broilers raised in the tropical environment (Oluyemi and Roberts, 2000). Other nutrients (lysine, methionine, calcium, phosphorus, ether extract and fibre) content of the diets were similar to that recommended by NRC. (1994)

Carcass Weight

The effect of organic acid diets on percentage dressed weight and other carcass parts are shown in Table 3. There were no significant ($P>0.05$) effects in all the measured parameters except the back-cut, shank and abdominal fat. The non significant effect of organic acid diets on dressed percentage and breast weights did not agree with the report of Leeson *et al.* (2005) that organic acid diets increased both dressed percentage and breast weight. This could be as a result of feeding the

Table 1: Ingredients and Nutrients Composition of Starter Diet

Ingredients	%
Maize	55.00
Soya bean meal	28.00
Fish meal	3.00
Palm kernel cake	10.30
Bone meal	3.00
Organic acid	-
Salt {NaCl)	0.25
Lysine	0.10
Methionine	0.10
Premix*	0.25
Total	100.00
Analyzed Values	
Crude protein	21.41
Energy MJME/kg)**	11.85
Ether extract	3.62
Crude fibre	4.38
Ash	6.54
Calcium	1.11
Phosphorous	0.86
Lysine**	1.12
Methionine**	0.55

* premix supplied per kg starter diet: vitamin A 15,000 I.U, vitamin D_3 13000 iu, thiamin 2mg, Riboflavin 6mg, pyridoxine 4mg, Niancin 40mg, cobalamine 0.05g, Biotin 0.08mg, chooline 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..
** Calculated.

acidified diets at the finisher phase only. Feeding of diets containing organic acids from the starter phase has been reported to improve growth and carcass yield of broiler chickens (Ndelekwute, 2011). The weight of the back-cut obtained from birds fed acetic acid dietary group though similar to other organic acid dietary groups, was significantly (P<0.05) smaller in birds fed the control diet. There were no significant differences between the back-cut of birds fed control diet and those of the birds fed butyric, citric and formic acid diets.

All broilers fed organic acid diets statistically deposited equal amount of abdominal fat compared to those of broilers fed control diet contrary to the report of Ndelekwute (2011) who reported that formic acid diet produced more fat than the control. He attributed it to the ability of the broilers fed formic acid diet to utilize energy efficiently which could lead to its excess deposited as fat. However, within the organic acid dietary groups, formic acid diet gave higher abdominal fat (P < 0.05) than the acetic and citric acid diets which agreed with the report of Ndelekwute (2011)

The effect of organic acid diets on internal organs of broiler chickens fed acidified diets at the finisher phase only is shown in Table 4 Significant differences (P<0.05) were observed in the weight of liver, kidney, heart, spleen, *caecum* and large intestine. There were no significant differences in the weight of crop, *proventriculus,* gizzard, pancreas, lung, gall bladder and small intestine. The weight of the liver of broilers fed acetic and citric acid diets and the control were similar (P>0.05) but were significantly (P<0.05) higher than those of broilers fed butyric and formic acid diets. The heart was significantly bigger in the control than in the organic acid dietary groups, while citric and formic acid diets produced bigger kidney than the control. It was observed that the control diet significantly produced smaller spleen than any of the organic acid diets. In all however, the weight of all the organs of all the groups fell within the normal range reported by Oluyemi and Reports (2000).This is an indication that the organic acids were not detrimental to the organs. Olomu (1995) reported that organs such as the liver and kidney could enlarge in

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
Organic acid	-	0.25	0.25	0.25	0.25
Bone meal	3.00	3.00	3.00	3.00	3.00
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
Lysine**	1.02	1.00	1.00	1.00	1.00
Methionine**	0.45	0.44	0.44	0.44	0.44

Per kg finisher diet): vitamin 10, 0001.u., vitamin D_3 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, pantthemic 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.

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

Parameters %)	CON	AA	BA	CA	FA	Sem
Slaughtered weight g)	1715.06	1720.01	1690.04	1716.05	1719.10	
Dressed carcass	62.23	62.34	61.68	62.14	62.41	3. 04
Breast weight	30.23	31.70	30.25	31.95	31.55	2.45
Back cut	23.97^{a}	22.01^{b}	22.80^{ab}	22.44^{b}	22.25^{ab}	1.33
Wing	12.09	12.47	12.82	12.25	12.77	1.03
Thigh	18.96	18.49	18.77	18.44	18.23	2.47
Drumstick	14.71	15.48	15.70	14.91	15.60	1.56
Abdominal fat	0.93^{ab}	0.75^{b}	0.94^{ab}	0.83^{b}	1.03^{a}	0.01

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

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

Parameters %)	CON	AA	BA	CA	FA	SEM
Slaughtered weight g)	1715.06	1720.01	1690.04	1716.05	1719.10	
Crop	1.46	1.29	1.45	1.55	1.39	0.02
Proventriculus	0.51	0.52	0.56	0.44	0.53	0.001
Gizzard	1.57	1.81	1.87	2.10	1.96	0.03
Liver	2.13a	2.06a	1.91b	2.18a	1.83b	0.34
Heart	0.65a	0.50b	0.48b	0.47b	0.48b	0.002
Pancreas	0.30	0.28	0.29	0.23	0.28	0.001
Kidney	0.68b	0.80ab	0.78ab	0.86a	0.81a	0.002
Lung	0.41	0.39	0.39	0.39	0.37	0.003
Spleen	0.09c	0.11b	0.12a	0.12a	0.11b	0.001
Gall bladder	0.15	0.13	0.12	0.12	0.12	0.001
Small intestine	4.41	4.36	4.38	4.90	4.93	0.56
Caecum	1.93a	1.36b	1.38 b	1.31b	1.25b	0.07
Large intestine	0.93a	0.55b	0.62b	0.59b	0.58b	0.008

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

response to toxic substances in the body.

It was also observed that the weight of the *caecum* and large intestine were higher in control group than in all the organic acid groups. There were no significant differences in the weights of *caecum* and large intestine of the organic acid dietary groups. This could be probably due to the ability of the organic acids to reduce the microbial load of the two segments as reported by Dibner (2004) and Ndelekwute (2011). High microbial presence is associated with larger *caecum* and large intestine of chickens due to fermentation activities as reported by (Choct, 2009).

In conclusion, it is suggested that the level of the organic acids could be increased in subsequent studies.

Sponsorship

This research was funded by the University of Uyo, Uyo, Nigeria and the authors are highly indebted to the University Authority

References

Abaza, M.I., Shehata, M.A., Shoieb, M.S. and Hassan, I.I. 2008. Evaluation of some natural feed additives in growing chicks diets. Int. J. Poult. Sci. 7(9): 872 - 879.

Alciceck, A., Bozkurt, M. and Cabuk, M. 2003. The effect of an essential oil combination derived from selected herbs growing wild in Turkey on broiler performance. S. Afr. J. Anim. Feed Sci. 8: 25 - 33.

Banerjee, G.C. 2007. A text book of Animal Husbandry. 8th ed. Oxford and IBH Pub. Co. Pvt Ltd., New Delhi, India. 450 – 467.

Bates, J., Jordens, J.Z. and Griffiths, D.T. 1994. Farm animals as a putative reservoir for Vancomycin-resistant *enterococcal* infection in man. J. Antimicrob. Chemother. 34: 507 - 514.

Cheeson, A. 1994. Probiotics and other intestinal mediators. In: Principles of pig science. (Cole, D. J. A., Wiseman, J. and Varley, M. A. Eds.).NottinghamUniversityPress:197 -214.

Choct, M. 2007. Enzymes in animal nutrition: The unseen benefits. Int. Res., University of New England Pub. Australia. 2(4): 23 – 25.

Choct, M. 2009. Managing gut health through nutrition. Brit. Poult. Sci. 50(1): 9 – 15.

Debevere, J.M. 1987. The use of buffered acidulant systems to improve the microbiological stability of acid foods. J. Food Microbiol. 4: 105 - 113.

Dibner, J. 2004. Organic acids: Can they replace antibiotic growth promoters. Feed Int. Dec. 25(12): 14 – 16

Duke, J.A. 1994. Biologically active compounds in important spices. In: Spices, Herbs and Edible Fungi. Charalambous, G. (ed.). Elsevier Science. 225 - 250.

Gao, J., Zhang, H. J., Yu, S.H., Wu, S.G., Yoon, I. Quigley, J., Gao, Y.P. and Qi, G.H. 2008. Effects of yeast culture in broiler diets on diets on performance and immuno modulatory functions. Poult. Sci. 87: 1377 - 1384.

Gibson, G.R., Robert, H.M., Van Loo, J.A.E., Rasfall, R.A. and Roberfroid, M.B. 2004. Dietary modulates of the human colomic microbiota: Updating the concept of prebiotics. Nutr. Res. Review. 17: 259 - 275.

Gwendolyn, J. 2002. Phytobiotics. In : Phytogenic Additives. Biomin pub. Austria. 1: 4 - 15.

Ivanov, I.E. 2003. A balancing act: Optimizing the gut microflora. Poult. Int. 42 (7): 33 - 37.

Leeson, S., Namkung, H., Ankongiovanni, H. and Lee, E. H. 2005. Effect of butyric acid on the performance and carcass yield of broiler chickens. *Poult. Sci*. 84: 1418 – 1422.

Makkink, C. 2001.Acid binding capacity in feedstuffs: Lowering the B-value especially for young animals. Feed Int. Oct. 22(10): 24 - 27.

Maynard, L.A., Loosli, J.K., Hintz, H. F. and Warner, R.C. 1981. Animal Nutrition 7th ed. Tata McGraw Hill Pub. New Delhi, India. 122 – 134.

Ndelekwute E. K., K. U. Amaefule, G. E. Onen, N. M. Anigbogu and J. U. Opara 2010 Effect of diets treated with organic acids on the performance of starter broiler chicks. 15th Annual Conf. Animal Science Assoc. Nig. Uyo, Nigeria. 456 - 458

Ndelekwute, E.K. 2011. Bioassessment of organic acids and black pepper (*Piper nigrum L*) using broilers. Ph.D dissertation, Michael Okpara University of Agriculture, Umudike, Nigeria.

Ndelekwute, E.K., Amaefule, K.U., Anigbogu, N.M. and Onen, G.E. 2011. Effect of organic acid-treated diets on nutrient digestibility and fecal moisture of broiler chickens. Proc. 36th Annual Conf. Nig. Soc.Anim. Prod, Abuja, Nigeria. 731 – 733

Ndelekwute, E.K., Uzegbu, H.O., Madu, H.C. and Assam, E.M. 2012. Organic acids as feed additive in pig and poultry diets: A review. Nierian Agric. J. 43: 27 – 38.

NRC. (1994).Nutrient Requirement for poultry. 9th ed. National Academy press. Washington DC, USA.

Olomu, J.M. 1995. Monogastric Animal Nutrition: Principles and Practice. Jachem Pub. Benin, Nigeria. 80 – 98.

Oluyemi J.A. and Roberts F.A. 2000. Poultry Production in Warm Wet

Climate. 2[nd] ed. Spectrum Books Ltd. Ibadan, Nigeria. 210.

Patterson, J.A. and Burkholder, K.M. 2003. Application of prebiotics and probiotics in poultry production. Poult. Sci. 82: 627 - 631.

Preston, T.R. **1996**. Tropical Animal Feeding: A Manual for Research Workers. FAO Animal Production and Health Pub. 126. Rome.

Raju, M.V.I.N., Reddy, V.R., Rama Rao, S.V. and Panda, A.K. 2006. Yeast: A multifunctional feed supplement for poultry. Poultry Int. June. 45 (7): 16 - 21.

Scott, M.L., Hili, N.F., Parson, E.H. (Jr.) and Buckner, J.H. **1969**. Studies on duck nutrition. 7: Effect of dietary energy protein relationships upon growth, feed utilization and carcass composition in market ducking. Poult. Sci. 38: 497 - 507.

Simmering, R. and Blaut, M. 2001. Pro and Prebiotics - the tasty guardian anglesƐ **Appl. Microbial. Biotechnol. 55: 19 - 28**

Steel, R.G.D. and Torrie, J.H. **1980**. Principles and Procedures of statistics. McGraw Hill Int. books Co. Sydney.

Sun, X. 2004. Broiler performance and intestinal alterations when fed drug free diets. M.Sc. Thesis, Virginia Polytechnic Institute and State University, Virginia, USA. 96.

Thaela, M.J. (1998). Effect of dietary supplementation with lactic acid on endogenous secretions. J. Ani. Feed Sci. and Tech. 7: 181 - 183.

Waldroup, A., Kaniawati, S. and Mauromoustakos A. **1995**. Performance characteristics and microbiological aspects of broilers fed diets supplemented with organic acids. J. Food Protection. 58(5): 482 - 489.

Windisch, W., Schedle, K., Plitzner, C. and Kroismayr, A. **2007**. Use of phytogenic products as feed additives for swine and poultry. J.Anim. Sci. 86 (E. Suppl.)E140 - E148.

Ziggers, D. **2009**. Probiotic in animal feed. Feed Tech.13(4): 20 – 21..

Received: 6[th] July, 2012
Accepted: 8[th] February, 2013