NATIONAL AGRICULTURAL AND FOOD CENTRE
RESEARCH INSTITUTE FOR ANIMAL PRODUCTION NITRA

Slovak J. Anim. Sci., 49, 2016 (2): 68–75
© 2016 NPPC
ISSN 1337-9984

COMPARATIVE STUDY BETWEEN ISA BROWN AND FULANI ECOTYPE CHICKENS SUPPLEMENTED WITH HUMIC ACID

A. O. LALA[1]*, N. OKWELUM[1], K. O. BELLO[1], N. A. FAMAKINDE[1], M. O. ALAMU[2]

[1]Institute of Food Security, Agricultural Research and Environmental Resources, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
[2]Department of Animal Nutrition, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria

ABSTRACT

A 32 week study was carried out to determine the influence of humic acid supplementation on the growth, production and egg qualities of ISA Brown and Fulani ecotype chickens. One hundred and eighty day old chicks of 90 each of ISA Brown and Fulani ecotype were randomly distributed in a 2x3 factorial arrangement of these breeds (ISA Brown and Fulani ecotype chickens) and three treatment groups 1) control with no humic acid supplementation, 2) supplementation with 1 $ml.L^{-1}$ humic acid and 3) 2 $ml.L^{-1}$ humic acid in drinking water. The six groups were replicated thrice with 10 chicks in each replicate. Humic acid supplementation ($p < 0.05$) increased body weight, improved feed conversion ratio, reduced mortality, increased hen-day production and egg weight in both ISA Brown and Fulani ecotype chickens (FEC). Feed intake ($p < 0.05$) increased in ISA Brown chickens with humic acid supplementation, while it decreased in Fulani ecotype chickens at eight weeks of age. At 20 weeks of age, both breeds consumed ($p < 0.05$) less feed with humic acid supplementation. pH of the different segments of gastrointestinal tract was ($p < 0.05$) lowered by humic acid supplementation. Shell thickness was significantly ($p < 0.05$) increased at 2 $ml.L^{-1}$ humic acid supplementation level in ISA Brown and FEC with ISA Brown groups having ($p < 0.05$) thicker shells when compared with FEC. High density lipoprotein ($p < 0.05$) increased across the treatment groups in ISA Brown, while these values ($p < 0.05$) decreased in ISA Brown groups supplemented with humic acid. Low density lipoprotein ($p < 0.05$) increased with humic acid supplementation in ISA Brown and FEC. The results of the present study indicated that the use of humic acid at 1 $ml.L^{-1}$ improved the body weight gain, overall feed intake and hen-day production in ISA Brown and Fulani ecotype chickens. However, better nutrient utilization was observed in Fulani ecotype chickens when compared with ISA Brown chickens.

Key words: chicks; growth; laying hens; lipid profile; egg qualities; humic acid

INTRODUCTION

The poultry industry has experienced tremendous growth; this growth has been with exotic chickens. The indigenous chicken genetic resources in Nigeria have been seriously endangered owing to genetic erosion through the rapid replacement by exotic breeds. The local chicken constitutes about 80 percent of the 120 million poultry birds found in Nigeria (FMA&RD, 2006). These chickens are also known for their adaptation superiority in terms of their resistance to endemic diseases and other harsh environmental conditions (Horst, 1989). The Nigerian indigenous chickens are thought to be suitable for the development of layer strains for the tropical environment since they posses some inherent advantages which include good fertility and hatchability, flavour, colour and texture of meat and egg that is preferred by local consumers, high degree of adaptability to prevailing conditions, high genetic variance in their performance, hardiness, disease tolerance, ease of rearing and ability to breed naturally (Adebambo *et al*., 2009).

Fulani ecotype chicken (FEC) is native to the Fulani tribe in the middle belt and northern parts of Nigeria.

***Correspondence:** E-mail: funmilala02@yahoo.com
Adebukunola Olufunmilayo Lala, Institute of Food Security, Agricultural Research and Environmental Resources, Federal University of Agriculture, P. M. B. 2240 Abeokuta, Ogun State, Nigeria
Tel.: +2348060395255 Fax: +23439244299

Received: November 23, 2015
Accepted: March 2, 2016

They are known to be superior in live weight than any other chicken ecotype within Nigeria (Olawunmi *et al*., 2008). The indigenous chickens provide immense benefits for keepers but their productivity is significantly hindered by genetic and management problems. The Nigerian Fulani Ecotype (FEC) chicken has been reported to have great potential for genetic improvement in growth and reproductive performance (Fayeye *et al.*, 2005). The need to improve on the productivity of FEC chickens could be achieved through the use of growth promoters. Improving productivity of this chicken ecotype through growth promoter will improve the economy of the local poultry farmers.

There has been increased interest in alternative natural growth promoters due to microbial resistance and residual effect of antibiotics, one of which is organic acid (Kopecky *et al*., 2012; Sheikh *et al*., 2011).

Organic acids are non-ionised, weak acid which can penetrate the bacterial cell wall and disrupt the normal physiology of some types of bacteria (Dhawale, 2005). Humic acid is one of the main components of humic substances which include humus, humic acid, fulvic acid, ulmic acid and trace minerals and it is the most well known of the group (Yildiz *et al*., 2006). The mode of their action is related to the reduction of pH in the upper intestinal tract, interfering with the growth of undesirable bacteria and modifying the intestinal flora (Kirchgessner and Roth, 1982). Organic acid has been reported to have the beneficial effects of improving feed conversion ratio, growth performance, enhancing mineral absorption (Kral *et al*., 2011; Galik and Rolinec, 2011; Petruska *et al*., 2012). Humic substances have many beneficial effects like antibacterial, antiviral and anti-inflammatory effects. They also improve immune system, reduce odour in faeces, cause a reduction in stress and play a role in liver function (Islam *et al*., 2005). The use of humic substances in animal brings a number of advantages for animal health and productive performance (Eren *et al*., 2000). According to FAO (2000), there is still a considerable and largely unexploited potential for increased production from local birds through improved management. The aim of this study was to determine the effects of humic acid on performance, egg traits and egg lipid profile of ISA Brown and Fulani ecotype chickens.

MATERIAL AND METHODS

Test supplement: Humic acid used is a product of Dynapharmlab Associate SDN. BHD. It contains chelated micronutrients, nitrogen 2.35 %, phosphorus 4.44 %, potassium 1.75 %, magnesium 0.36 %, iron 867 ppm, manganese 223 ppm, copper 144 ppm, zinc 153 ppm, boron 0.011 %, molybdenum 0.002 % and humic acid 0.68 %.

Experimental management and design

A total of 180 one day-old female chicks of 90 ISA Brown and 90 Fulani ecotype chicks were randomly allocated into 3 treatment groups: 1) control with no humic acid supplementation, 2) supplementation with 1 $ml.L^{-1}$ humic acid and 3) 2 $ml.L^{-1}$ humic acid supplementation in drinking water. Each treatment group was replicated thrice with 10 chicks per replicate. The experiment was conducted for 32 weeks period with all the chickens kept under uniform management conditions throughout the experimental period. Diets were formulated for the chick (0-8 weeks), grower (8-20 weeks) and layer phases of the experiment. Nutrient compositions of diets were determined according to the AOAC (1990) as shown in Table 1. Drinking water was replaced every day.

Growth performance: Birds were weighed per replicate at the beginning and on weekly basis. Feed intake was recorded weekly and calculated as g per bird; mortality was recorded as it occurred.

Gastrointestinal tract pH measurement

At the end of 8 weeks, two hens from each replicate were randomly selected and slaughtered by cervical dislocation. The gastrointestinal tract (GIT) was removed; 10 g each of contents from the crop, gizzard, duodenum, jejunum and ileum were collected in sterilized bottles (1:10 dilution) and the value of the pH for the different segments of the GIT was measured immediately using a digital pH meter.

Production performance: Between 28th and 32nd week of the experiment, eggs were collected daily and egg production was calculated on a hen-day basis. Eggs were weighed. Feed intake was recorded weekly and calculated as g per hen per day.

Egg quality measurement

A total of 18 eggs per treatment, 6 eggs per replicate were randomly selected on weekly basis within 24 hours of lay. The eggs were individually weighed on an electronic balance, the length and width was measured using Vernier calliper to determine the egg shape index (ESI). The eggs were broken into a flat surface where yolks were separated from the whites and then weighed. The shells were carefully washed of any adhering albumen, air dried and weighed. The thickness of each shell was determined using a micrometer screw gauge. Yolk and shell percentages were determined in relation to the egg weight. Yolk colour was determined by matching with one of the matching bands of the Roche colour fan of 12 graded colours. Albumen height

Table 1: Composition of experimental basal diet (%)

Ingredient	Starter (0 – 8 weeks)	Grower (9 – 20 weeks)	Layers
Maize	53.00	58.00	47.00
Groundnut cake	12.00	9.00	5.00
Soyabean meal	18.00	8.00	20.00
Fish meal	4.00	0.00	1.00
Wheat offal	6.90	19.00	15.80
Bone meal	3.00	3.00	2.50
Oyster shell	2.00	2.00	8.00
*Premix	0.25	0.25	0.25
Salt	0.30	0.25	0.25
Lysine	0.30	0.25	0.10
Methionine	0.25	0.25	0.10
Total	100.00	100.00	100.00
Crude protein (%)	22.80	16.93	17.06
Metabolizable energy ($MJ.kg^{-1}$)	11.72	11.11	10.93

*Premix for chick per kg of diet: Vitamin A 10,000 iu; vitamin D3 900 iu; copper 0.1 mg; vitamin E 50.0 mg; manganese 8.5 mg; vitamin K 2.0 mg; iron 75.0 mg; vitamin B1 2.0 mg; folic acid 5.0 mg; vitamin C 26.0 mg; pantothenic acid 20.0 mg; vitamin B6 2.0 mg; choline 1200 mg; vitamin B12 0.01 mg; niacin 50 mg; zinc 70 mg; biotin 0.2 mg.

*Premix for grower per kg of diet: Vitamin A 8,000 iu; vitamin D3 1,200 iu; copper 2.0 mg; vitamin E 31.0 mg; manganese 80 mg; vitamin B2 10.0 mg; pantothenic acid 150.0 mg; iodine 1.2 mg; selenium 0.1 mg; cobalt 2 mg.

*Premix for layer per kg of diet: Vitamin A 10,000 iu; vitamin D3 200 iu; vitamin E 100 iu; vitamin K 20 mg; thiamine 15 mg; riboflavin B2 40 mg; pyridoxine B6 15 mg; niacin 150 mg; pantothenic acid 50 mg; folic acid 5 mg; biotin 0.2 mg; choline chloride 12 mg; antioxidant 1.25 g; manganese 0.8 g; zinc 0.5 g; iron 0.2 g; copper 0.5 g; iodine 0.12 g; selenium 2 mg; cobalt 2 mg.

was measured using tripod spherometer and Haugh unit was calculated according to Haugh (1937).

Yolk lipid profile: At the end of the 32nd week of the experiment, 3 eggs from each replicate were randomly chosen to determine yolk lipid profile. The eggs were hard-cooked, allowed to cool, after which the weight of the boiled eggs were noted. The yolks were carefully separated, weighed and crumbled. 1 g sample of each yolk was homogenized with 15 ml of chloroform-methanol 2:1 (v/v), thoroughly mixed and filtered. Egg homogenate filtrates were designated egg yolk samples. Total cholesterol, HDL cholesterol, total triglycerides concentrations of egg yolk were determined using RANDOX® cholesterol assay kit.

Statistical analysis

All data were subjected to analysis of variance using the General Linear Model Procedure SAS software (SAS, 2002). Treatment means were separated using the Duncan multiple range test at $p < 0.05$.

RESULTS

The effects of humic acid supplementation on the growth performance of ISA Brown and Fulani ecotype chickens (FEC) are shown in Table 2. Compared with the control group, the supplementation of humic acid resulted in significant ($p < 0.05$) increase in body weight of ISA Brown and FEC at 8 and 20 weeks of age. Irrespective of the level of humic acid supplementation, ISA Brown chicks had similar body weight gain while, the body weight gain of FEC was significantly ($p < 0.05$) higher at 2 $ml.L^{-1}$ supplementation level.

Feed intake ($p < 0.05$) increased with humic acid supplementation in ISA Brown chicks, while it decreased in FEC at 8 weeks. However at 20 weeks of age, feed intake ($p < 0.05$) decreased in both ISA Brown and FEC with humic acid supplementation. Fulani ecotype chickens consumed ($p < 0.05$) less feed with or without humic acid supplementation when compared with the ISA Brown groups at 8 and 20 weeks.

Feed conversion ratio (FCR) was similar in all ISA Brown groups and FEC control group while the ratio decreased as the level of humic acid supplementation increased in FEC at 8 weeks. The highest FCR at 20 weeks was obtained from ISA Brown pullets without humic acid supplementation while FEC supplemented with 2 $ml.L^{-1}$ humic acid had the least value. Similar FCR values were recorded from the other treatment groups. Significant ($p < 0.05$) percentage mortality was recorded from ISA Brown and FEC without supplementation

Table 2: Growth performance of ISA Brown and Fulani ecotype chickens supplemented with humic acid

	ISA Brown			Fulani ecotype				p-value		
	Humic acid supplementation ($ml.L^{-1}$)									
Parameter	0	1	2	0	1	2	SEM	HA	B	HAxB
Initial weight (g/bird)	33.17	33.19	33.16	33.19	33.19	33.16	0.01	0.1470	0.4103	0.4410
Final weight at 8 wks (g/bird)	562.34^{cd}	575.76^{ab}	578.26^{ab}	553.86^{d}	569.61^{bc}	584.697^{a}	2.76	0.0001	0.4026	0.0005
Weight gain at 8 weeks (g/bird)	529.18^{cd}	542.57^{ab}	545.10^{ab}	520.67^{d}	536.42^{bc}	551.53^{a}	2.76	0.0001	0.4011	0.0005
Feed intake at 8 wks (g/bird)	1729.26^{b}	1761.52^{a}	1764.53^{a}	1685.04^{c}	1648.00^{d}	1629.80^{d}	13.01	0.7723	0.0001	0.4011
Feed conversion ratio	3.27^{a}	3.25^{a}	3.24^{a}	3.24^{a}	3.07^{b}	2.96^{c}	0.03	0.0067	0.0003	<.0001
Mortality at 8 wks (%)	6.67^{a}	0.00^{b}	0.00^{b}	3.33^{ab}	0.00^{b}	0.00^{b}	0.90	0.0252	0.4752	0.1357
Body weight at 20 wks (g/bird)	1383^{c}	1500^{a}	1500^{a}	1410^{bc}	1463^{ab}	1490^{a}	13.73	0.0018	0.7344	0.0164
Weight gain at 20 wks (g/bird)	820.99^{b}	924.24^{a}	921.74^{a}	856.14^{ab}	893.73^{ab}	905.30^{a}	12.15	0.0118	0.8429	0.0589
Feed intake 8-20 wks (g/bird)	6399.41^{a}	6270.48^{b}	6251.14^{b}	5869.96^{c}	5603.00^{d}	5558.20^{d}	81.16	<.0001	<.0001	<.0001
Feed conversion ratio	7.82^{a}	6.79^{b}	6.78^{b}	6.86^{b}	6.27^{bc}	6.16^{c}	0.15	0.0005	0.0004	0.0006

^{a,b,c} Means on the same row with different superscript are different ($p < 0.05$)
SEM = Standard error of mean
HA = Humic acid, B = Breed

alone; there was no mortality among ISA Brown and FEC supplemented with humic acid.

The pH of the gastrointestinal tract (GIT) of ISA Brown and FEC supplemented with humic acid as indicated in Table 3 showed that the GIT was significantly ($p < 0.05$) affected by humic acid supplementation and breed. The pH of the crop, gizzard, duodenum, jejunum and ileum of ISA Brown and FEC ($p < 0.05$) reduced with humic acid supplementation. The ($p < 0.05$) highest pH values in each of the GIT segment were recorded in ISA Brown chicks in the control group while, FEC supplemented with 2 $ml.L^{-1}$ had the ($p < 0.05$) least pH values in these GIT segments.

Age at first lay, hen-day production, feed intake and egg weight were significantly ($p < 0.05$) improved with humic acid supplementation in ISA Brown and FEC as revealed in Table 4. Highest ($p < 0.05$) hen-day production was obtained with FEC supplemented with humic acid while, the least was recorded from ISA Brown chickens without supplementation. Similar hen-day production percentages were obtained from the other treatment groups. Yolk percentage was significantly ($p < 0.05$) higher and similar in all FEC groups and ISA Brown not supplemented with humic acid. This was ($p < 0.05$) lower in ISA Brown chickens supplemented with humic acid.

Shell thickness was significantly ($p < 0.05$) increased at 2 $ml.L^{-1}$ humic acid supplementation level in ISA Brown and FEC although, shell thickness from ISA Brown chicken groups was ($p < 0.05$) higher than

Table 3: Gastrointestinal pH of ISA Brown and Fulani ecotype chickens supplemented with humic acid

	ISA Brown			Fulani ecotype				p-value		
	Humic acid supplementation ($ml.L^{-1}$)									
Parameter	0	1	2	0	1	2	SEM	Humic	Breed	HAxB
Crop	5.17^{a}	5.01^{b}	4.87^{c}	4.41^{d}	4.23^{e}	4.15^{e}	0.10	<.0001	<.0001	<.0001
Gizzard	4.87^{a}	4.75^{b}	4.68^{c}	4.16^{d}	3.66^{e}	3.38^{f}	0.14	0.0352	<.0001	<.0001
Duodenum	5.71^{a}	5.58^{b}	5.47^{c}	5.45^{cd}	5.42^{d}	5.42^{d}	0.03	0.0020	<.0001	<.0001
Jejunum	5.84^{a}	5.72^{b}	5.63^{c}	5.59^{c}	5.46^{d}	5.41^{d}	0.04	<.0001	<.0001	<.0001
Ileum	6.55^{a}	6.32^{b}	6.22^{b}	6.03^{c}	5.92^{cd}	5.83^{d}	0.06	0.0001	<.0001	<.0001

^{a,b,c} Means on the same row with different superscript are different ($p < 0.05$)
SEM = Standard error of mean
HA = Humic acid, B = Breed

Table 4: Production performance and egg qualities of ISA Brown and Fulani ecotype chickens supplemented with humic acid

	ISA Brown			Fulani ecotype				p-value		
	Humic acid supplementation (ml.L^{-1})									
Parameter	0	1	2	0	1	2	SEM	Humic	Breed	HAxB
Age at 1st egg (days)	153^a	146^b	145^b	142^c	139^d	139^d	1.17	0.0003	<.0001	<.0001
Hen-day production (%)	87.33^c	92.67^b	92.00^b	92.67^b	95.33^a	95.33^a	0.68	<.0001	<.0001	<.0001
Feed intake (g/bird/day)	113.00^a	110.00^b	109.00^b	91.67^c	90.00^{cd}	89.67^d	2.48	0.0007	<.0001	<.0001
Egg weight (g/egg)	56.37^c	59.34^b	64.75^a	40.52^f	43.56^e	46.17^d	2.16	<.0001	<.0001	<.0001
Yolk (%)	29.06^a	27.49^b	27.02^b	28.90^a	29.19^a	29.59^a	0.25	0.2832	0.0025	0.0002
Shell (%)	9.49^b	9.41^b	9.30^b	9.86^a	9.57^{ab}	9.44^b	0.06	0.0443	0.0244	0.0570
Shell thickness (mm)	0.33^{bc}	0.34^b	0.35^a	0.32^d	0.32^d	0.33^c	0.03	0.0021	<.0001	0.0002
Egg shape index	0.67^b	0.67^b	0.73^a	0.67^b	0.65^c	0.74^a	0.01	<.0001	0.3262	<.0001
Haugh Unit (%)	83.06^b	84.12^a	84.30^a	78.75^c	79.26^c	78.92^c	0.61	0.0720	<.0001	<.0001
Yolk colour	8.00^c	9.00^b	10.00^a	6.00^e	7.00^d	7.00^d	0.33	<.0001	<.0001	<.0001

^{a,b,c} Means on the same row with different superscript are different ($p < 0.05$)
SEM = Standard error of mean
HA = Humic acid, B = Breed

those from the FEC groups. Haugh unit ($p < 0.05$) improved with humic acid supplementation in ISA Brown chickens while, there was no significant ($p > 0.05$) effect of humic acid on all FEC groups. Haugh unit was significantly ($p < 0.05$) higher in ISA Brown chickens when compared with FEC. Yolk colour was significantly ($p < 0.05$) higher in the groups supplemented with humic acid when compared to those in the control groups. ISA Brown chickens supplemented with 2 ml.L^{-1} produced eggs with deeper yolk colour, which was closely followed by the ISA Brown group supplemented with 1 ml.L^{-1} humic acid. The ($p < 0.05$) lowest yolk colour was obtained from FEC in the control group.

Table 5 showed the egg lipid profile of ISA Brown and FEC supplemented with humic acid. Triglycerides ($p < 0.05$) decreased in the eggs of ISA Brown and FEC supplemented with humic acid. However, egg cholesterol ($p < 0.05$) increased with humic acid supplementation. The highest cholesterol value was obtained from ISA Brown supplemented with 2 ml.L^{-1} humic acid and the least from FEC supplemented with 2 ml.L^{-1} humic acid. High density lipoprotein ($p < 0.05$) increased and decreased across the treatment groups in ISA Brown and FEC respectively. Low density lipoprotein ($p < 0.05$) increased with humic acid supplementation in ISA Brown and FEC. The highest low density lipoprotein value was recorded from ISA Brown chickens supplemented with 2 ml.L^{-1} humic acid while, the least value was obtained from FEC without humic acid supplementation.

Table 5: Lipid profile of eggs from ISA Brown and Fulani ecotype chickens supplemented with humic acid

	ISA Brown			Fulani ecotype				p-value		
	Humic acid supplementation (ml.L^{-1})									
Parameter	0	1	2	0	1	2	SEM	Humic	Breed	HAxB
Triglycerides (mg.g^{-1})	151.74^a	117.99^b	112.39^{bc}	94.46^{bc}	87.70^c	87.90^c	6.11	0.0402	0.0001	0.0008
Cholesterol (mg.g^{-1})	75.36^d	77.50^c	79.28^a	74.64^d	78.32^b	70.98^e	0.68	0.0777	0.0240	<.0001
High density lipoprotein (mg.g^{-1})	44.13^c	45.59^b	47.67^a	39.66^d	30.57^e	32.52^f	1.57	0.1018	<.0001	<.0001
Low density lipoprotein (mg.g^{-1})	24.65^c	25.64^b	26.65^a	21.47^e	23.61^d	24.44^c	0.40	<.0001	<.0001	<.0001

^{a,b,c} Means on the same row with different superscript are different ($p < 0.05$)
SEM = Standard error of mean
HA = Humic acid, B = Breed

DISCUSSION

The improved body weight gain of birds supplemented with humic acid when compared with the un-supplemented group could be due to the beneficial effect of humic acid on the gut flora. The beneficial microbiological and pH-decreasing abilities of humic acid especially at the upper part of the gastrointestinal tract might have had resulted in the inhibition of intestinal bacteria leading to the reduced metabolic needs, thereby increasing the availability of nutrients to the host. Humic acid stimulates the immune system receptors in the gut lining to protect against pathogens to promote growth (Kocabagli *et al.*, 2002; Karaoglu *et al.*, 2004). By modifying the intestinal pH, Owing *et al*. (1990) reported that organic acid improves the solubility of the feed ingredients, digestion and absorption of nutrients. Sheikh *et al.* (2010) revealed that organic acid supplementation facilitated nutrient absorption to a greater extent and thus boosted growth.

The acid anion of humic acid has been shown to complex with calcium, phosphorus, magnesium and zinc which results in an improved digestibility of these minerals and serves as substrate in the intermediary metabolism (Kishi *et al.*, 1999).

The increase in feed intake of ISA Brown chicks and decrease in FEC with humic acid supplementation may be as a result of the differences in breed. Kucukersan *et al.* (2005) showed that the average daily feed consumption of hen fed diets with humic acid was significantly decreased compared with the control group. While some researchers reported that dietary humate supplementation increased feed intake (Hayirli *et al*., 2005). The improvement in the FCR among FEC supplemented with humic acid could be possibly due to better utilization of nutrients resulting in increased body weight. Supplementation of humic acid at levels of 1 and 2 $g.kg^{-1}$ were reported to improve feed efficiency when compared with hens fed control diet (Yoruk *et al*., 2004). Organic acids improve the absorption and conversion of nutrients in the body, and improve overall gastric function (Park *et al*., 2009).

In this study, humic acid was able to improve the survivability of the birds; this could be attributed to the reduction in the intestinal pH and the ability to inhibit the growth of microbial pathogens. Humic acid was observed to show antibacterial, antiviral, antithyroidal and anti-inflammatory effects in animals, thus improves the immune system (Islam *et al*. 2005).

Humic acid has the ability to influence in particular the metabolism of protein carbohydrates of microbes by catalytic means. This leads to a direct devastation of bacterial cells or virus particles (Huck *et al*., 1991; Ricke, 2003).

The use of humic acids in animal feeds improved animal health forming a protective film on the mucous epithelium of the membrane and tract against infection and toxin (Kucukersan *et al*., 2005). The lower pH values in GIT of birds supplemented with humic acid is a confirmation of the pH decreasing ability of humic acid. The addition of acidifiers to the diet for broilers lowered the pH of the crop and gizzard content (Andrys *et al*., 2003).

Egg production and egg weight among the groups supplemented with humic acid is indicative of better utilization of nutrients. Egg production values of laying hens fed 1 and 2 $g.kg^{-1}$ humic acid were higher than those of the control group (Tancho, 1999; Yoruk *et al*., 2004). However, some studies found that humic acid had no effect on egg production of laying hens and laying quails (Kucukersan *et al*., 2005; Yalcın *et al*., 2005). Soltan (2008) found that organic acid supplementation increased egg production by about 5.77 % compared to untreated group. Park *et al.* (2002) reported a positive effect of organic acid on laying performance. Dietary humic substances improved egg weight as reported by Wang *et al.* (2007).

The increased egg shell quality in eggs produced by birds supplemented with humic acid might be as a result of the presence of calcium in humic acid and increase in calcium absorption. Increased permeability allowed easier transfer of minerals from the blood o the bone and cells (Enviromate, 2002). Organic acid is reported to improve utilization of mineral feed additives, increasing the availability of calcium and other minerals (Omogbenigun *et al*., 2003). The pH reducing and antimicrobial effects of the organic acid may assist in gut acidifiers and appear to be a good solution for poor egg shell quality (Dibner and Butin, 2002; Dhawale, 2005). Thick egg shell is essential for protection against the penetration of pathogenic bacteria (Swiatkiewicz *et al*., 2010).

Egg lipid profile showed certain interaction between breeds and their capability to take up dietary nutrients and transfer them to their products. Sarica *et al.* (2009) reported higher cholesterol in the eggs of commercial layers and lower in local pure breeds. However, Rizzi and Chiericato, (2010) revealed that yolk cholesterol was found at higher concentration in local Mediterranean laying hen breeds compared with commercial laying hybrids.

CONCLUSION

Supplementing ISA Brown and Fulani ecotype chickens with humic acid increased body weight, egg production, egg weight, shell thickness and improved feed conversion. Humic acid at the rate 1 $ml.L^{-1}$ can be used for production efficiency in ISA Brown and Fulani ecotype chickens.

AKNOWLEDGEMENT

The authors are grateful to the Institute of Food Security, Agricultural Research and Environmental Resources for the provision of the Fulani ecotype chickens to carry out this study under the Fulani ecotype multiplication project.

REFERENCES

ADEBAMBO, O. A. – IKEOBI, C. O. N. – OZOJE, M. O. – ADEBAMBO, O. A. 2009. Variation in growth performance of pure and crossbred meat type chickens. *Nigerian Journal of Animal Production*, vol. 36 (2), 2009, p. 211–227.

ANDRYS, R. – KLECKER, D. – ZEMAN, L. – MAREČEK, E. 2003. The effect of changed pH values of feed in isophosphoric diets on chicken broiler performance. *Czech Journal of Animal Science*, vol. 48, 2003, p. 197–206.

AOAC. 1990. *Official Methods of Analysis*. 14th edn. Association of Official Analytical Chemists. Arlington, Virginia.

DHAWALE, A. 2005. Better eggshell quality with a gut acidifier. *Poultry International*, vol. 44, 2005, p. 18–21.

DIBNER, J. J. – BUTIN, P. 2002. Use of organic acids as a model to study the impact of gut microflora on nutrition and metabolism. *Journal of Applied Poultry Research*, vol. 11, 2002, p. 453–463.

ENVIROMATE, T. M. 2002. Effects of humic acid on animals and humans (literature review and current research). Effects of humic acid. Enviromate Inc. 8571 Boat Club Road, Forth Worth, Texas 76179. http://www. enviromateinc.com /effect sha.asp

EREN, M. – DENIZ, G. – GEZEN, S. S. – TURKMEN, I. I. 2000. Effects of humates supplemented to the broiler feeds on fattening performance, serum mineral concentration and bone ash. *Veterinary Journal of Ankara University*, vol. 47, 2000, p. 255–263.

FAO, 2000. Food and Agricultural Organization small scale poultry production, FAO Corporate Document Repository, http://www.fao.org/docrep/008/y5169e01.htm#

FAYEYE, T. R. – ADESHIYAN, A. B – OLUGBAMI, A. A. 2005. Egg Traits, Hatchability and Early Growth Performance of the Fulani – Ecotype Chicken. *Livestock Research for Rural Development*, vol. 17 (8), 2005, Art. #94. http:// www.lrrd. org/lrrd17/8faye17094.htm.

FMA&RD. 2006. Federal Ministry of Agriculture and Rural Development, Federal Department of Livestock and Pest Control Service. 'Nigeria Poultry Population' Highly pathogenic avian influenza standard operating procedure. February, 2006.

GALIK, B. – ROLINEC, M. 2011. The effect of phytogenic feed additives on the performance of non-ruminant Proc. International Ph.D. workshop on welfare, biotechnology and quality of animal production, Nitra, Slovak University of Agriculture, vol. 19, 2011.

HAUGH, R. R. 1937. The Haugh unit for measuring egg quality. *US egg and poultry magazine*, vol. 43, 1937, p. 552–555.

HAYIRLI, A. – ESENBUGA, N. – MACIT, M. – LACIN, E. – KARAOGLU, M. – KARACA, H. – YILDIZ, L. 2005. Nutrition practice to alleviate the adverse effects of stress on laying performance, metabolic profile, and egg quality in peak producing hens: I. The humate supplementation. *Asian-Australian Journal of Animal Science*, vol. 18, 2005, p. 1310–1319.

HORST, P. 1989. Native fowl as reservoir for genome and major genes with direct and indirect effects on adaptability and their potential for tropical oriented breeding plans. *Archiv für Geflugelkunde*, vol. 53, 1989, p. 93–101.

HUCK, J. A. – PORTER, N. – BUSHELD, M. E. 1991. Effect of humates on microbial activity. *Journal of General Microbiology*, vol. 137, p. 2321–2329.

ISLAM, K. M. – SCHUHMACHER, A. – GROPP, J. M. 2005. Humic acid substances in animal agriculture. *Pakistan Journal of Nutrition*, vol. 4, 2005, p. 126–134.

KARAOGLU, M. – MACIT, M. – ESENBOGA, N. – DURDAG, H. – TURGUT, L. – BILGIN, O. C. 2004. Effect of supplemental humate at different levels on the growth performance slaughter and carcass traits of broilers. *International Journal of Poultry Science*, vol. 3, 2004, p. 406–410.

KIRCHGESSNER, M. – ROTH, F. X. 1982. Fumaric acid as a feed additive in pig nutrition. *Pig News Information*, vol. 3, 1982, p. 259–264.

KISHI, M. – FUKAYA, M. – TSUKAMOTO, Y. – NAGASAWA, T. – KAKEHANA, K. – NISHIZAWA, N. 1999. Enhancing effect of dietary vinegar on the intestinal absorption of calcium in overiectomized rats. *Bioscience Biotechnology Biochemistry*, vol. 63, 1999, p. 905–910.

KOCABAGLI, N. – ALP, M. – ACAR, N. – KAHRAMAN, R. 2002. The effects of dietary humate supplementation on broiler growth and carcass yield. *Poultry Science*, vol. 81, 2002, p. 227– 230.

KOPECKY, J. – HRNCAR, C. – WEIS, J. 2012. Effect of Organic Acids Supplement on Performance of Broiler Chickens. *Animal Sciences and Biotechnologies*, vol. 45 (1), 2012, p. 51–54.

KRAL, M. – ANGELOVICOVA, M. – MRAZOVA, Ľ. – TKACOVA, J. – KLIMENT, M. 2011. Probiotic and acetic acid of broiler chickens performance. *Scientific Papers Animal Science and Biotechnologies*, vol. 44, 2011, p. 149–152.

KUCUKERSAN, S. – KUCUKERSAN, K. – COLPAN, I. – GONCUOGLU, E. – REISLI, Z. – YESILBAG, D. 2005. The effects of humic acid on egg production and egg traits of laying hen. *Veterinarni Medicina*, vol. 50 (9), 2005, p. 406–410.

OLAWUNMI, O. O. – SALAKO, A. E. – AFUWAPE, A. A. 2008. Morphometric and differenciation and assessment of function of the Fulani and Yoruba ecotype indigenous chickens of Nigeria. *International Journal of Morphology*, vol. 26, 2008, p. 975–980.

OMOGBENIGUN, F. O. – NYACHOTI, C. M. – SLOMINSKI, B. A. 2003. The effect of supplementing microbial phytase and organic acids to a corn-soybean based diet fed to early weaned pigs. *Journal of Animal Science*, vol. 81, 2003, p. 1806–1813.

OWINGS, W. J. – REYNOLDS, D. L. – HASIAK, R. J. – FERKET, P. R. 1990. Influence of dietary supplementation with *Streptococcus faecium* M-74 on broiler body weight feed conversion; carcass characteristics and intestinal microbial colonization. *Poultry Science*, vol. 69, 1990, p. 1257–1264.

PARK, J. H. – PARK, G. G. – RYU, K. S. 2002. Effect of feeding organic acid mixture and yeast culture on performance and egg quality of laying hens. *Korean Journal of Poultry Science*, vol. 29, 2002, p. 109–115.

PARK, K. W. – RHEE, A. R. – UM, J. S. – PAIK, I. K. 2009 Effect of dietary available phospohorus and organic acids on the performance and egg quality of laying hens. *Journal of Applied Poultry Research*, vol. 18, 2009, p. 598–604.

PETRUSKA, P. – TUSIMOVA, E. – KALAFOVA, A. – HASCIK, P. – KACANIOVA, M. – KOLESAROVA, A. – CAPCAROVA, M. 2012. Effect of propolis in chicken diet on selected parameters of mineral profile. *Journal of Microbiology, Biotechnology and Food Sciences*, vol. 1, 2012, p. 1090–1097.

RICKE, S. C. 2003. Perspectives on the use of organic acids and short chain fatty acids as antimicrobials. *Poultry Science*, vol. 82 (4), 2003, p. 632–639.

RIZZI, C. – CHIERICATO, G. M. 2010. Chemical composition of meat and egg yolk of hybrid and Italian breed hens reared using an organic production system. *Poultry Science*, vol. 89, 2010, p. 1239–1251.

SARICA, M. – SEKEROGLU, A. – KARACAY, N. 2009. Effect of genotype on fatty acid and cholesterol contents of hen‘s egg. *Asian Journal of Chemistry*, vol. 21, 2009, p. 511–516.

SAS. 2002. SAS/STAT Statistical Analytical Systems User‘s guide (Release 9.1 Edition). SAS Institute Inc. Cary, North Carolina.

SHEIKH, A. – TUFAIL, – B. – GULAM, – A. B. – MASOOD, S. M. – MANZOOR, R. 2010. Effect of Dietary Supplementation of Organic Acids on Performance, Intestinal Histomorphology, and Serum Biochemistry of Broiler Chicken. *Veterinary Medicine International*, 2010, Article ID 479485, 7 pages http://dx.doi.org.10.4061/2010/479485

SHEIKH, A. – TUFAIL, B. – GULAM, A. B. – MASOOD, S. M. – MASHUQ, R. – SYED, S. 2011. Response of broiler chicken to dietary supplementation of organic acids. *Journal of Central European Agriculture*, vol. 12 (3), 2011, p. 498–508.

SOLTAN, M. A. 2008. Effect of organic acid supplementation on egg production, egg quality, and some blood serum parameters in laying hens. International *Journal of Poultry Science*, vol. 7, 2008, p. 613–621.

SWIATKIEWICZ, S. – KORELESKI, J. – ARCZEWSKA, A. 2010. Laying performance and egg shell quality in laying hens fed diets supplemented with prebiotics and organic acids. *Czech Journal of Animal Science*, vol. 55 (7), 2010, p. 294–306.

TANCHO, A. 1999. The effect of humic acid supplement on egg performance and egg quality of laying hen during 28-47 weeks of age. 30th Anniversary Kaset Ladkrabang, 24-26 June 1999. http://www.kmitl.ac.th/agritech30/example.doc

WANG, Q. – KIM, H. J. – CHO, J. H. – CHEN, Y. J. – YOO, J. S. – KIM, I.H. 2007. Effects of supplemental humic substances on egg production and quality in laying hens. *Poultry Science*, vol. 86, p. 519.

YALCIN, S. – ERGUN, A. – EROL, H. – YALCIN, S. – OZSOY, B. 2005. Use of L-carnitine and humate in laying quail diets. *Acta Veterinaria Hungarica*, vol. 53, 2005, p. 361–370.

YILDIZ, G. – SACAKLI, P. – GUNGOR, T. 2006. The effect of dietary Jerusalem artichoke (*Helianthus tuberosus)* on performance, egg quality characteristics and egg cholesterol content in laying hens. *Czech Journal of Animal Science,* vol. 8, 2006, p. 349–354.

YORUK, M. A. – GUL, M. – HAYIRLI, A. – MACIT, M. 2004. The effects of supplementation of humate and probiotic on egg production and quality parameters during the late laying period in hens. *Poultry Science*, vol. 83, 2004, p. 84–88.