

EFFECT OF WATER ACIDIFICATION ON PERFORMANCE, CARCASS CHARACTERISTIC AND SOME VARIABLES OF INTERMEDIARY METABOLISM IN CHICKS

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The effect of water acidification on performance and some biochemical parameters was studied in 100 one day old broiler chicks (Ross 308) divided into control and treatment groups (n = 50) supplied with drinking water supplemented with acidifier (blend of acids) in a concentration of 0.2 % during the whole experimental period. Final body weight, hot carcass yield, abdominal fat pad and metabolic variables in the blood serum except for aspartate aminotransferase (AST) level which was significantly lower on 35th day (p < 0.01), were not affected by the acidifier. Higher weight gain in the treated group due to better feed efficiency was observed in the first phase. Higher feed intake in the third phase of the trial caused higher final feed conversion ratio (p < 0.01). Use of the acidifier positively affected bird health status (zero mortality) which was reflected in higher EEI values observed in the treated group on the 35th, as well as 42nd day of the trial.

Key words: acidifier, biochemical parameters, broiler, hot carcass yield, production

INTRODUCTION

As the use of antibiotics as growth promoters in the European Community was banned in January 2006 because of the risk of development of resistance, the interest in alternative substances which would have the same or better influence on animal health and production has increased. Organic acids and their salts could be a possible alternative. The beneficial effect of organic acids lies in the inhibition of pathogens by the penetration of their dissociated carboxyl groups into the microbial cells which has a positive influence on the gastrointestinal microflora composition (Vieira *et al.*, 2008). Lower susceptibility to *Campylobacter* infection (Chaveerach *et al.*, 2004), better production (Lückstädt *et al.*, 2004; Abdel-Fattah *et al.*, 2008), and in laying hens better egg quality (Dhawale, 2005) were observed after the acidification of feed or drinking water in poultry farming. The influence on the microbial balance of the gastrointestinal tract was also observed after the application of acidifying substances into the litter for broilers,

what could also have a positive effect on environmental conditions in the farming establishment (Garrido *et al.*, 2004).

The objective of the present study was to investigate the effect of water acidification on performance, hot carcass yield, abdominal fat pad and some biochemical parameters in broilers.

MATERIAL AND METHODS

In this research, a total of one hundred unsexed one day old broiler chicks (Ross 308) obtained from a commercial supplier were used. Chicks were weighed, randomly divided into two groups (50 chicks per group) and housed on deep bedding in agreement with the technological instruction for Ross 308 chicks, with controlled light, temperature, animal hygiene and feeding regime. The acidifier (Schaumacid Drink – blend: ascorbic acid, lignosulphonic acid, lactic acid, ammonium formate and ammonium propionate) was added to drinking water for the treatment group (group A) in a concentration of 0.2 % during the whole experimental period. Complete mixtures in mash form (according to the stages of growth) and drinking water were offered to birds *ad libitum*. The composition of the feed mixtures is shown in Table 1. No antibiotic growth promoters nor anticoccidial drugs were used in the diets.

Birds were individually weighed and feed consumption was observed weekly. The feed conversion ratio was determined as the ratio between the feed intake and weight gain at each phase of the trial. Mortality was recorded as it occurred and percentage of mortality was determined on the 35th day and at the end of the study. The following equation was used for the evaluation of the results using European Efficiency Index (EEI): $[(\text{live weight (kg)} \times \text{liveability}) / (\text{age (days)} \times \text{feed conversion})] \times 100$.

Blood samples were collected from ten birds in each group on the 14th and 35th day of trial from the jugular vein. Biochemical analysis (total protein, albumin, uric acid, glucose, total lipids, cholesterol, triglycerides, alkaline phosphatase ALP, aspartate aminotransferase AST, calcium and phosphorus) was done with the aid of commercial Bio-La-Tests (Pliva-LaChema Brno Ltd., Czech Republic).

At the end of the trial, the birds were left for 10 - 12 h without feed, weighed and slaughtered by cervical dislocation, processed by decapitation, neck, feathers and feet removal and evisceration. Twenty birds per group (ten from each sex) were used for evaluation of hot carcass yield and abdominal fat pad.

Diets were analyzed for dry matter, crude protein, ether extract, crude fiber and ash by the AOAC (2001) (Table 1).

The experiment was carried out at the Institute of Animal Nutrition and Dietetics at the University of Veterinary Medicine and Pharmacy in Košice in compliance with the ethical requirements.

Statistical evaluation of the effects of acidifier on body weight, feed conversion ratio, European Efficiency Index and biochemical parameters of chickens between the groups were determined by Student T-test (level of significance set at $p < 0.01$).

Table 1. Composition, nutrient and metabolizable energy content of diets

Ingredients (g.kg ⁻¹)	week 1 - 2	week 3 - 5	week 6
Maize	435	500	500
Wheat	121	90	104
Soybean meal (45 %)	360	330	310
Vegetable oil	40	40	50
Limestone	20	16	15
Vitamin-mineral premix ^{1,2,3}	20	20	20
Lysine	4	4	1
Analysis			
Dry matter (g)	896.9	900.2	893.9
Crude protein (g.kg ⁻¹ DM)	249.9	230.5	218.7
Ether extract (g.kg ⁻¹ DM)	70.1	71.9	80.3
Crude fiber (g.kg ⁻¹ DM)	36.7	44.3	42.6
Ash (g.kg ⁻¹ DM)	82.3	66.9	66.0
ME (MJ.kg ⁻¹ DM)	13.3	13.3	13.5

DM – Dry matter; ME – Metabolizable energy

^{1, 2, 3} mineral-vitamin premix (per kg) ¹– Ca 95 g, P 135 g, Na 75 g, Mg 5 g, DL-methionine 80 g, vit. A 600,000 IU, D₃ 135,000 IU, E 900 mg, K₃ 150 mg, pantothenic acid 600 mg, niacin 4000 mg, cholin chloride 20,000 mg, B₆ 150 mg, B₁₂ 900 µg, biotin 3000 µg, folic acid 76,000 µg, vit. C 2000 mg, Fe 1500 mg, Cu 500 mg, Zn 3000 mg, Mn 5000 mg, I 25 mg, Se 23 mg, Co 10 mg, ²– Ca 100 g, P 135 g, Na 75 g, Mg 5 g, DL-methionine 80 g, vit. A 425,000 IU, D₃ 84,000 IU, E 900 mg, K₃ 100 mg, pantothenic acid 420 mg, niacin 3400 mg, cholin chloride 14,200 mg, B₆ 100 mg, B₁₂ 640 µg, biotin 2150 µg, folic acid 54,500 µg, vit. C 1400 mg, Fe 1500 mg, Cu 500 mg, Zn 3000 mg, Mn 5000 mg, I 25 mg, Se 23 mg, Co 10 mg, ³– Ca 110 g, P 145 g, Na 75 g, Mg 9 g, DL-methionine 55 g, vit. A 370,000 IU, D₃ 135,000 IU, E 900 mg, K₃ 95 mg, pantothenic acid 370 mg, niacin 3880 mg, cholin chloride 14,000 mg, B₆ 95 mg, B₁₂ 560 µg, biotin 1850 µg, folic acid 47,000 µg, vit. C 1240 mg, Fe 1500 mg, Cu 500 mg, Zn 3000 mg, Mn 5000 mg, I 25 mg, Se 23 mg, Co 10 mg

RESULTS

There were no significant differences in initial body weights of chicks between groups at the beginning of the experiment (Control 41.5 g; A 42.2 g). Whereas at the end of the 2nd week the average body weight was higher in the treated group, at the end of the 5th week was higher in the control group (Table 2). The final body weight at the end of the experiment (6th day) was about 0.45 % higher in the control group than in the treated group. The difference was not statistically significant.

The average body weight gain and feed conversion ratio values are shown in Table 3. Highest body weight gains in the first phase of the study were in the treated group (3.02 %), in the second phase in the control group (3.68 %) and in the third phase again in the treated group (about 6.80 %). Considering the whole

trial period the body weight gain was highest in the control group, being 0.48 % higher compared with the treated group.

Table 2. Average body weight (g/chick) ($\bar{x} \pm \text{SEM}$)

Week	Control	A
1 - 2	342.9 \pm 11.6	352.8 \pm 8.2
3 - 5	1926.9 \pm 56.0	1878.5 \pm 37.6
6	2476.6 \pm 74.7	2465.5 \pm 57.0

Feed conversion ratio in the first phase of the study was lower in the treated group and in the second and third phase was lower in the control group. The differences were not statistically significant between groups. Considering the whole trial period the feed conversion ratio was significantly higher in the treated group than in the control group ($p < 0.01$).

Table 3. Average body weight gains (g/chick) and feed conversion ratio (kg feed consumed/kg weight gain) ($\bar{x} \pm \text{SEM}$)

Week	Control	A
Body weight gain		
1 - 2	301.4	310.5
3 - 5	1584.1	1525.8
6	549.6	587.0
1 - 5	1885.5	1836.3
1 - 6	2435.1	2423.3
Feed conversion ratio		
1 - 2	1.15 \pm 0.017	1.11 \pm 0.003
3 - 5	1.71 \pm 0.013	1.74 \pm 0.004
6	2.29 \pm 0.033	2.40 \pm 0.033
1 - 5	1.62 \pm 0.007	1.63 \pm 0.003
1 - 6	1.77 \pm 0.010 ^a	1.82 \pm 0.003 ^c

^{a,c} significant differences ($p < 0.01$)

Through the whole trial period the mortality was lower in the treated group (0 %) than in the control group (4.08 %).

Higher EEI values were observed in the treated group on the 35th and 42nd dday a of the trial (329.5; 323.2 respectively) due to lower mortality, which represents a difference of 0.86 % and 1.09 % in comparison to the control group (326.7; 319.7 respectively) (Figure 1). The differences between groups were not statistically significant.

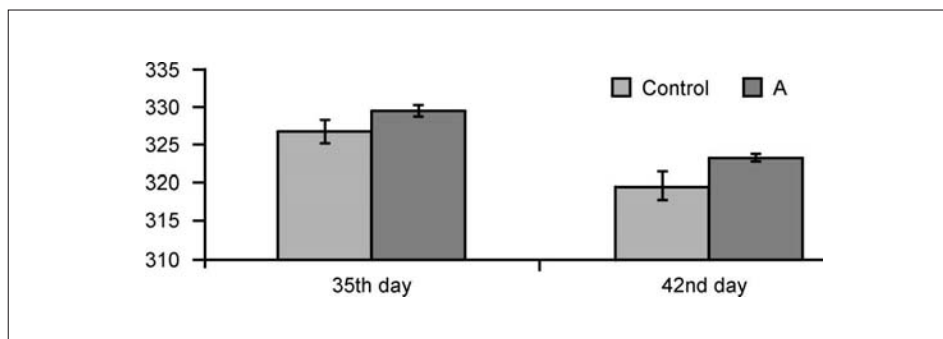


Figure 1. European Efficiency Index (EEI) on 35th and 42nd day of the study

No significant differences were also found in the hot carcass yield and abdominal fat pad (Table 4).

Table 4. Hot carcass yield (%) and abdominal fat pad (% hot carcass weight) on the 42nd day of the study ($\bar{x} \pm \text{SEM}$; n = 20)

	n	Control	A
Hot carcass yield			
Female	10	73.91 \pm 0.56	72.84 \pm 0.32
Male	10	73.83 \pm 0.21	72.81 \pm 0.35
Total	20	73.87 \pm 0.28	72.82 \pm 0.23
Abdominal fat pad			
Female	10	2.03 \pm 0.23	1.78 \pm 0.15
Male	10	1.47 \pm 0.13	1.75 \pm 0.12
Total	20	1.78 \pm 0.15	1.77 \pm 0.09

The metabolic variables in the blood serum analysed on the 14th and 35th day of the study are shown in Table 5. Higher concentrations of total protein on the 14th day and higher concentrations of albumin and uric acid on the 14th day, as well as 35th day of the study were observed in the treatment group. The differences were not statistically significant. Variables of energy metabolism (glucose, total lipids, cholesterol, triglycerides), ALP, Ca and P were not significantly affected by water acidification on the 14th, as well as on the 35th day of the study. Significant differences were observed only in the activity of AST on the 35th day of the trial ($p < 0.01$), which were lower than in the control group.

Table 5. Metabolic variables in chicken blood serum after 14 and 35 days of experiment ($\bar{x} \pm \text{SEM}$; n = 10)

	After 14 days		After 35 days	
	Control	A	Control	A
Total protein (g.l ⁻¹)	26.54 ± 1.89	27.05 ± 0.82	29.93 ± 0.90	27.21 ± 0.83
Albumin (g.l ⁻¹)	12.90 ± 0.30	12.97 ± 0.47	13.85 ± 0.50	14.49 ± 0.18
Uric acid (μmol.l ⁻¹)	287.18 ± 39.66	301.08 ± 26.60	198.48 ± 23.90	206.26 ± 23.40
Glucose (μmol.l ⁻¹)	13.81 ± 0.34	14.17 ± 0.32	12.54 ± 0.67	14.21 ± 0.35
Total lipids (g.l ⁻¹)	5.27 ± 0.26	6.31 ± 0.53	3.88 ± 0.40	4.76 ± 0.29
Cholesterol (mmol.l ⁻¹)	3.66 ± 0.39	4.88 ± 0.25	3.00 ± 0.14	3.10 ± 0.21
Triglycerides (mmol.l ⁻¹)	2.94 ± 0.50	3.11 ± 0.42	0.61 ± 0.13	0.65 ± 0.12
ALP (μkat.l ⁻¹)	386.80 ± 53.02	297.07 ± 54.85	111.46 ± 27.48	83.44 ± 15.77
AST (μkat.l ⁻¹)	1.70 ± 0.15	1.77 ± 0.15	3.17 ± 0.32 ^a	1.64 ± 0.16 ^b
Ca (mmol.l ⁻¹)	2.63 ± 0.05	2.79 ± 0.14	2.38 ± 0.06	2.34 ± 0.06
P (mmol.l ⁻¹)	2.35 ± 0.10	2.47 ± 0.10	2.77 ± 0.14	2.74 ± 0.10

^{ab} significant differences (p < 0.01)

DISCUSSION

In this study chicken drinking acidified water reached about 0.48% less body weight gain at significantly higher feed conversion (p < 0.01) than chicken in the control group. Weight gain and feed conversion for the whole trial were smaller also in the study by Biggs and Parsons (2008), where 1, 2 and 3 % gluconic acid diets were fed to chicks. Depressed weight gain was observed by the use of diets with 4 and 6 % gluconic acid, 4 % malic acid and 3 % citric acid. There were no significant differences in feed efficiency for any dietary treatments. In a study by Pirgozliev *et al.* (2008) birds fed diets containing fumaric and sorbic acid in concentrations of 0.5, 1.0 and 1.5 % had lower weight gain compared to the control group. Chickens fed 0.5 % and 1.5 % fumaric acid had higher feed efficiency compared to the control birds. Similarly, birds fed 0.5 % and 1.5 % fumaric acid had an improved feed efficiency than those fed 1 % and 1.5 % sorbic acid. Watkins *et al.* (2004) found no significant improvement in average weights and feed conversion in broiler chicken drinking acidified water (water pH from 3 to 5) for the whole trial (42 days). The feed conversion at day 42 showed that birds on continuous application of water pH 4 and pH 5, as well as intermittent application of water pH 3 and pH 4 had the best feed conversions. Significantly higher live body weight and body weight gain and significantly lower feed conversion in chicks were observed in a study by Abdel-Fattah *et al.* (2008) where diets acidified with 1.5 % or 3 % organic acids (citric acid, acetic acid or lactic acid) were used. No statistically significant differences were found between the acidifier groups.

In our study, the mortality was zero in the treatment group and 4.08 % in the control group. Against our results, Leeson *et al.* (2005) observed a slightly higher mortality in chicken fed diets containing 0.2 and 0.4 % butyric acid than in the control group.

We observed that addition of the acidifier to drinking water did not influence the hot carcass yield and abdominal fat pad. These results support the observations of various researchers that supplied organic acids to broiler chicks (Denli *et al.*, 2003; Leeson *et al.*, 2005).

A significant decrease of AST activity in the blood serum on the 35th day in the treatment group does not show any harmful effect of supplemented acidifier on the health of chickens as increased levels of AST is symptomatic for hepatic damage (Harr, 2006). Other biochemical parameters (total protein, albumin, uric acid, glucose, total lipids, cholesterol, triglycerides, ALP, Ca, P) were not significantly affected. Abdel-Fattah *et al.* (2008) found significantly lower serum concentrations of cholesterol and total lipids and significantly higher concentrations of Ca and P in chicks fed acidified diets (citric acid, acetic acid or lactic acid in 1.5 % or 3 % concentration) in comparison with the control group. The lowest cholesterol levels were recorded in chicks which received either acetic acid (1.5 or 3 %) or 3 % citric acid. Differences among control and treatment groups in total protein, albumin, uric acid and AST were not statistically significant. El-Hakim *et al.* (2009) also observed insignificant differences in total protein and albumin in chicks fed diets with 0.2 % citric acid.

In conclusion, our study showed that final body weight, hot carcass yield, abdominal fat pad and metabolic variables in blood serum were not influenced by the addition of acidifiers in a concentration of 0.2 % to drinking water. In the treated group the higher weight gain in the first phase of the trial was caused by better feed efficiency and in the third phase by higher feed intake, which was the reason of higher final feed conversion ratio ($p < 0.01$). Use of acidifiers positively affected bird health status (zero mortality) which was reflected in higher EEI values observed in the treatment group on the 35th as well as 42nd day of the trial.

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UTICAJ ZAKIŠELJAVANJA VODE NA PROIZVODNE KARAKTERISTIKE, PRINOS MESA I NEKE PARAMETRE INTERMEDIJARNOG METABOLIZMA BROJLERSKIH PILIĆA

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SADRŽAJ

U ovom radu je ispitivan uticaj zakišeljavanja vode na proizvodne karakteristike i neke biohemijske parametre kod ukupno 100 jednodnevnih pilića hibrida Ross 308 podjeljenih u dve jednake grupe. Sredstvo za zakišeljavanje dodavano je jedinkama ogledne grupe u koncentraciji od 0,2% tokom tova od 42 dana. Završna telesna masa, randman pre rashlađivanja, sloj abdominalne masti i vrednosti biohemijskih parametara sa izuzetkom aktivnosti aspartat aminotransferaze nisu bili promenjeni opisanim tretmanom. Na kraju prve faze ogleda, telesna masa pilića ogledne grupe je bila veća usled boljeg iskorišćavanja hrane dok je u trećoj fazi unos hrane bio povećan. Na kraju ogleda, konverzija hrane je bila značajno bolja u oglednoj grupi ($p < 0,01$). Evropski indeks efikasnosti (EEI) je bio veći u oglednoj grupi 35-og i 42-og dana ogleda.