Effect of the neutral electrolyzed water (ANK) on broiler performance

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SUMMARY

The experiment aimed to evaluate the potential of the neutral electrolysed water (ANK) to stimulate broiler metabolism. ANK has pH 7.3-7.8 and 400 mg/l active chloride. A 3-week experiment used 144 Ross 308 broilers, aged 21 days. The chicks were assigned to 3 groups which received the same basal diet with 20.29 g%g protein (growing period) and 17.06 g%g during the finishing period. The experimental groups (E1 and E2) differed from the control group (C) by the different content of ANK, of active chloride, from the water given to the broilers: normal water for the control group (C); water with 1.5% ANK (6 mg active Cl/l water) - (E1) and water with 2.25% ANK (9 mg active Cl/l water) - (E2). The experimental results show that the average daily gain was significantly greater ($p<0.05$) in group E2 (62.97±3.77 g/day/broiler) than in groups E1 (58.09±3.13 g/day/broiler) and C (55.63±2.69 g/day/broiler). Feed conversion ratio also was the best in group E2, with 2.12 g feed/g gain, being significantly better ($p<0.05$) than in the other two groups: 2.34 and 2.60 g feed/g gain in groups E1 and C, respectively.

Keywords: neutral electrolysed water, broiler, metabolism, feed conversion ratio

INTRODUCTION

The electrolyzed water is regarded lately as a new disinfectant that is used increasingly by the food industry for the efficient cleaning of the installations from the processing flow for animal products: courtyard poultry carcasses (Fabrizio et al., 2002; Park et al., 2002), egg shell (Russel, 2003); plant seeds: alfalfa seeds (Kim et al., 2003); green lettuce (Koseki et al 2004a, b).

The electrolyzed water has several advantages over the traditional disinfectants: efficient disinfection, easy operation, rather cheap and ecological. The use of electrolyzed water as non-thermal method, on different foods didn't affect adversely their organoleptic properties: colour, smell,

flavour, texture (Achiwa and Nishio, 2003; Al-Haq et al, 2005; Yoshida et al., 2004; Kim et al, 2003).

The greatest advantage of using electrolyzed water to inactivate the pathogens is the lower impact on the environment and users because of the non-existence of chemicals (Abadias et al., 2008). The use of neutral electrolyzed water (ANK) in the water given to poultry is an alternative route of treatment which has a beneficial influence on their health state (Ramanauskaite and Pogoreloviene, 2006; Olteanu et al, 2010).

The purpose of the study was to evaluate if the use of neutral electrolyzed water as disinfecting agent in poultry houses has a beneficial effect on broiler performance and on the quality of broiler breast meat. The experiment was financed from a research project of the National Romanian research program 51-077/2007, PNII, supported by the Romanian Ministry of Education and Research.

MATERIAL AND METHODS

The trial was conducted for a period of 3 weeks on 144 Ross 308 broilers (both sexes) aged 21 days with initial body weight: 800.048g (group C); 791.333g (group E1) and 814.333g (group E2). The chicks were assigned to 3 groups with 48 broilers per group, housed in three-tier battery cages, with 8 cages with 6 broilers/cage in each group. The light regimen was up to 16 hours of light throughout the experimental period. The broilers had free access to the feed and water.

The experimental groups (E1 and E2) received neutral electrolyzed water – anolyte (ANK) with pH 7.4 and 400 mg/l active chloride. The groups had different concentrations of chloride in the drinking waters, as follows:

- The control group (C) received the basal diet (BD) + normal water
- Group E1 received the BD + water with 1.5% ANK (6 mg active chloride/l water)
- Group E2 received the BD + water with 2.25% ANK (9 mg active chloride/l water)

The diet consisted mainly of corn, rapeseed meal, soybean meal and gluten (Table 1). The diet was optimised on the basis of the chemical determinations conducted on the feed ingredients, using a mathematical model (Burlacu et al., 1999) in agreement with the feed requirements recommended for the intensive rearing of this hybrid. The finished compound feeds were analysed to determine their feeding quality (Table 2).

The chemical methods used for the assays on the feeds samples were as follows: dry matter using the gravimetric method – SR ISO 6496:2001, with Sartorius analytical scale (Gottingen, Germany) and BMT stove ECOCELL

Blueline Comfort (Neuremberg, Germany); crude protein using the Kjeldahl method – SR EN ISO 5983-2:2009, with a semiautomatic KJELTEC auto 2300 – Tecator system; ether extractives using organic solvents – SR ISO 6492:2001, with a SOXTEC 2055 – Tecator system; crude fiber by hydrolysis in alkalis and acids– SR EN ISO 6865:2002, using the FIBERTEC 2010–Tecator system; ash using the gravimetric method, calcination at 550^0C –SR EN ISO 2171:2010, with a Caloris CL 1206 oven; calcium by titration – SR ISO 6490-1:2006; phosphorus using spectrophotometry CE regulation nr. 152 / 2009 with a UV-VIS- V530 spectrophotometer; trace elements: iron, copper, manganese, zinc using atomic absorption spectrometry –SR EN ISO 6869:2002, with a –SOLLAR M 650339 absorption spectrophotometer.

Table 1. Diet composition (%)

Item	Grower, 21-35 days	Finisher, 36-42 days
Corn	60.14	64.8
Rapeseed meal		10
Soybean meal	26.9	15
Gluten	6	2
Oil	2.8	4
Monocalcium phosphate	1.1	1.2
Calcium carbonate	1.6	1.4
Salt	0.2	0.3
Methionine	0.05	0.1
Lysine	0.15	0.14
Choline	0.06	0.06
*Premix	1	-
**Premix	-	1
TOTAL raw ingredients	100	100

*Content per kg diet: vitamin A-11000IU; vitamin D3-2000IU; vitamin E-27IU, vitamin K3-3mg; vitaminB_1-2mg; vitamin B_2-4mg; pantothenic acid -14.85mg; nicotinic acid -27mg; vitamin B_6-3mg; vitamin B_7-0.04mg; vitamin B_9-1mg; vitamin B_{12}-0,018mg; vitamin C-20mg; Mn-80mg; Fe-80mg; Cu-5mg; Zn-60mg; Co-0.37mg; I-1.52mg; Se-0.18 mg, coccidiostatic.

** Content per kg diet: vitamin A-9000IU; vitamin D3-2000IU; vitamin E-18IU, vitamin K3-2mg; vitaminB_1-2mg; vitamin B_2-3,2mg; pantothenic acid -9.9mg; nicotinic acid -23mg; vitamin B_6-2mg; vitamin B_7-0.04mg; vitamin B_9-0.5mg; vitamin B_{12}-0.009mg; Mn-62mg; Fe-70mg; Cu-5mg; Zn-48mg; Co-0.37mg; I-0.76mg; Se-0.18 mg.

The average daily feed intake (g/day/broiler); body weight (g); average daily gain (g/day/broiler), feed conversion ratio (g feed/g gain) were monitored throughout the experimental period.

Four broiler chicks were slaughtered from each group at the end of the experiment and breast muscle samples were collected and assayed for protein, fat and ash using the analytical methods mentioned above. The fatty acids were determined using gas chromatography method according to - SR CEN

ISO/TS 17764-2:2008 while cholesterol was determined using gas chromatography method according to–ISO 12228:1999.

The data were subjected to Origin 5.0 software for variance analysis, using t-Test (two populations) and a significance level at 0.05.

Table 2. Gross chemical composition of the raw ingredients and diets

Specification	Dry matter, %	Protein, %	Ether extr., %	Fibre, %	Ash, %	Gross energy, MJ/kg
Corn	85.71	10.95	3.32	2.71	2.19	17.84
Rapeseed meal	90.04	29.86	3.28	15.11	6.88	17.56
Soybean meal	89.51	48.95	0.99	6.40	7.46	19.02
Corn gluten	91.63	73.75	1.15	1.01	1.52	21.72
Grower diet	89.11	20.29	5.27	3.65	5.03	17.25
Finisher diet	89.57	17.06	6.55	4.72	5.19	17.40

RESULTS AND DISCUSSION

Tables 3 and 4 and Figure 1 show the results of broiler performance.

Table 3. Average daily feed intake (g /day /broiler)

Period	C	E 1	E 2
Week I (21-28 days)	93.53 ±17.42	86.82 ±15.36	88.22 ±14.17
Week II (29-35 days)	137.79 ±11.99	128.47 ±11.54	136.13 ±12.76
Week III (36-42 days)	151.26 ±9.38	148.24[c] ±9.15	157.12[b] ±5.05
Total experimental period (21-49 days)	127.53 ±28.27	121.18 ±28.70	127.16 ±31.46

[b]significant differences(p<0,05) from E1; [c]significant differences (p<0,05) from E2.

Because the experiment was conducted on chickens during the growth and finishing periods, the values if the average daily intake (Table 3) increased from the experimental week I (21-28 days) to the experimental week III (36-42 days) and ranged from 86.82±15.36 g/day/broiler in group E1 to 157.12 ±5.05 g/day/broiler in group E2, with significant differences ($p<0.05$) in week III, between groups E1 and E2. However, for the entire experimental period (21-42 days), the average daily feed intake did not differ between the groups.

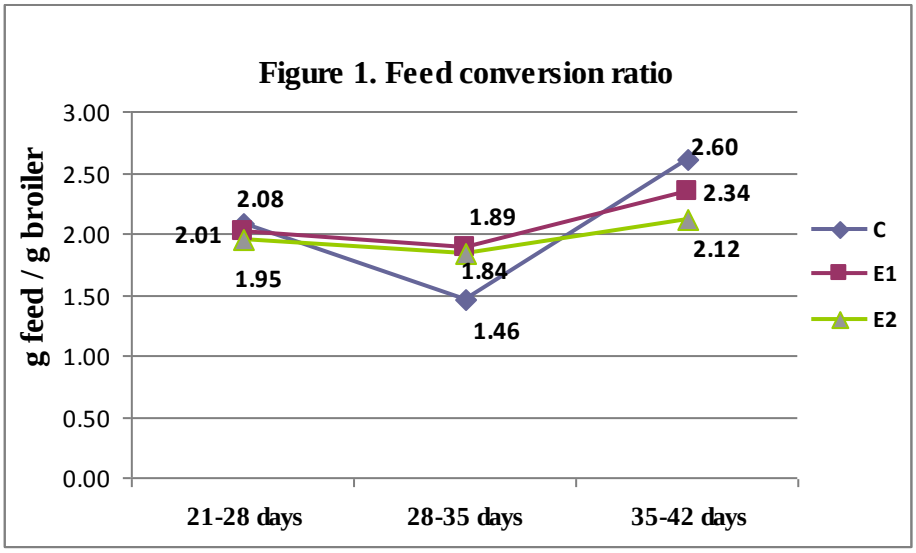
The body weight of the chickens during the experimental period 21 – 42 days (Table 4) was significantly different ($p<0.05$) starting with week II (35 days), 1332.75 ±91.94 g/broiler, in group E2, compared to 1247.63 ±56.13 g/broiler, in group C. At the end of the experiment (42 days) the differences persisted between group E1 (1709.46 ±86.35 g/broiler), and E2 (1819.60 ±96.22 g/broiler), compared to group C (1654.27 ±67.70 g/broiler).

Table 4. Body weight and average daily weight gain (average values)

Period	C	E 1	E 2
Body weight (g/broiler)			
End of week I -28 days	800.05 ±39.66	791.33 ±59.37	814.33 ±53.89
End of week II -35 days	1247.63 ±56.13	1266.50 ±83.75	1332.75[a] ±91.94
End of week III -42 days	1654.27±67.70	1709.46[c]±86.35	1819.60[a.b]±96.22
Average daily weight gain (g/day/broiler)			
Week I (21-28 days)	44.87 ±4.13	43.11 ±4.94	45.29 ±3.71
Week II (29-35 days)	63.94[b.c] ±3.19	67.88[a.c] ±3.89	74.06[a.b] ±5.28
Week III (36-42 days)	58.09[b.c] ±4.51	63.28[a.c] ±3.25	69.55[a.b] ±5.38
Total exp. period (21-42 days)	55.63 ±2.69	58.09[c] ±3.13	62.97[a.b] ±3.77

[a]significant differences (p<0,05) from C; [b]significant differences (p<0,05) from E1; [c]significant differences (p<0,05) from E2.

Significant differences (p<0.05) were noticed starting with week II in the weight gain between groups E1 and E2 and groups C. For the entire experimental period, the highest value of the daily weight gain was noticed for group E2 (62.97±3.77 g/day/broiler), which is significantly different (p<0.05) from groups E1 (58.09±3.13 g/day/broiler), and C (55.63±2.69 g/day/broiler).



The lowest value of the feed conversion ratio at the end of the experiment (Fig. 2), 2.12 g feed/g weight was noticed in group E2, 9.40% lower compared to group E1 and 18.46% lower compared to group C, the differences being statistically significant (p<0.05).

Table 5 shows the protein, fat and ash content of the breast meat samples collected after the slaughter performed in the end of the experiment. There

were no significant differences between the experimental and control groups, the fat percentage being lower than the value of 1.8% mentioned in the literature (Komprda et al., 1999).

Table 5. Chemical composition of the breast meat samples (average values)

Specification	Dry matter, %	Protein, %	Fat, %	Ash, %
Control	23.91±0.34	21.46±0.32	1.14±0.05	1.07±0.03
Exp. 1	24.23±0.20	21.55±0.18	1.49±0.03	1.14±0.06
Exp. 2	23.93±0.21	21.47±0.11	0.91±0.02	1.12±0.03

The fatty acids profile of the beast meat samples (Table 6) showed no difference between the experimental and control groups.

Table 6. Fatty acids profile of the beast meat samples (average values; g/100 g fat)

Specification		C	E 1	E 2
Miristic acid [a]	C14:0	0.84	1.08	1.04
Miristoleic acid [b]	C14:1	0.13	0.12	0.15
Pentadecanoic acid [a]	C15:0	0.14	0.16	0.15
Pentadecenoic acid [b]	C15:1	0.4	0.48	0.38
Palmitic acid [a]	C16:0	22.02	21.23	22.42
Palmitoleic acid [b]	C16:1	3.99	3.28	4.01
heptadecanoic acid [a]	C17:0	0.21	0.18	0.15
Heptadecenoic acid [b]	C17:1	0.16	0.21	0.16
Stearic acid [a]	C18:0	6.96	8.05	7.67
Oleic acid cis [b]	C18:1n9	32.75	32.16	33.12
Oleic acid trans [b]	C18:1n11	0.2	0.26	0.29
Linoleic acid cis [c]	C18:2n6	24.62	23.57	24.64
Linolenic acid γ [c]	C18:3n6	0.29	0.23	0.19
Linolenic acid α [c]	C18:3n3	0.54	0.49	0.41
Conjugated linoleic [c]- CLA	C18:2	0.06	0.13	0.16
Octadecatetraenoic acid [c]	C18:4n3	0.37	0.40	0.30
Eicosadienoic acid [c]	C20:2n6	0.37	0.36	0.27
Arachidonic acid [c]	C20:4n6	1.67	2.15	1.46
Eicosapentaenoic acid [c]	C20:5n3	0.28	0.3	0.41
Docosatetraenoic acid	C22:4n6	0.48	0.61	0.39
Docosapentaenoic acid [c]	C22:5n3	0.09	0.11	0.06
Docosahexaenoic acid [c]	C22:6n3	0.06	0.13	0.05
Other fatty acids		3.37	4.31	2.12

[a]Saturated fatty acids (SFA); [b]Monounsaturated fatty acids (MUFA); [c]Polyunsaturated fatty acids (PUFA)

The total amount of fatty acids (Table 7) was not significantly different ($p<0.05$) in the experimental groups compared t the control group and were close to the values reported by the literature: 31.58% for the saturated fatty acids; 38.69% for the monounsaturated fatty acids, and 29.73% for the

polyunsaturated fatty acids (Komprda et al., 1999). The ratio of the fatty acids was not different either, between the experimental and control groups and were close to the value reported in the literature: 0.94 for the ratio of the polyunsaturated/saturated fatty acids (PUFA/SFA); 0.81 for the ratio of the polyunsaturated/monounsaturated fatty acids (PUFA/SFA), and 1.22 for the ratio of the monounsaturated/saturated fatty acids (MUFA/SFA) (Komprda et al., 1999).

Table 7. Ratio of the saturated to unsaturated fatty acids

Specification	C	E 1	E 2
SFA, g/100g fat	30.17	30.70	31.43
MUFA, g/100g fat	37.63	36.51	38.11
PUFA, g/100g fat	28.83	28.48	28.34
PUFA / SFA	0.96	0.93	0.90
PUFA / MUFA	0.77	0.78	0.74
MUFA / SFA	1.25	1.19	1.21

The cholesterol content (Table 8) of the breast meat samples showed no significant differences ($p<0.05$) between the experimental and control groups, the values being lower than those reported in the literature, of 53 mg/100g (Komprda et al., 2003)

Table 8. Cholesterol content

Specification	Cholesterol (mg/100g fresh sample)
Breast meat - Control	46.001±0.259
Breast meat – Experimental 1	46.465±1.855
Breast meat – Experimental 2	42.786±0.274

CONCLUSIONS

The administration of 6 (E1) and 9 (E2) mg active chloride/l water to broiler chicken during the experimental period (21-42 days) showed that:

- The average feed intake calculated for the entire experimental period was not different between groups;
- Body weight, at the end of the experimental period, was the highest in group E2, being significantly ($p<0.05$) different from the other groups;
- The average daily weight gain, calculated for the entire experimental period, was highest in group E2, being significantly ($p<0.05$) different from the other groups;
- Feed conversion ratio (g feed/g weight) was best, 2.12 g feed/ g weight in group E2, being significantly ($p<0.05$) different from the other groups;

- The liveability percentage was 100% in all groups.
- No differences between the experimental and control groups were noticed for the breast meat samples content of fatty acids and cholesterol.

Therefore, in terms of the most significant values of broiler performance and of fatty acids and cholesterol content of the breast meat samples, we can recommend the use of water with 2.25% ANK (9 mg active chloride/l water).

REFERENCES

Abadias M., Usall J., Oliveria M., Alegre I., Vinas I. (2008): Efficacy of neutral electrolyzed water (NEW) for reducing microbial contamination on minimally-processed vegetables. International Journal of Food Microbiology, 31, 123(1-2):151-8.

Achiwa N. and Nishio T. (2003): The use of electrolyzed water for sanitation control of eggshells and GP center. Food Sci. Technol. Res., 9: 100-103.

Al-Haq MI, Sugiyama J, Isobe S (2005): Applications of Electrolyzed Water in Agriculture and Food Industries. Food Sci. Technol. Res., 11:135-50.

Burlacu Gh., Cavache A., Burlacu R., Surdu I. (1999): Ghid pentru alcatuirea ratiilor de hrana la pasari. ISBN: 973-8036-00-3.

Chang P. C. (2003): HACCP Update in fish process in Taiwan. In D. F. Hwang & T. Noguchi (Eds.), Proceedings of international scientific symposium on marine toxins and marine food safety (pp. 137–141). Keelung: National Taiwan Ocean University.

CSPI -Center for Science in the Public Interest (2006): Outbreak Alert report. http://www.cspinet.org/foodsafety/outbreak_report.html.

Fabrizio K. A., Sharma R. R., Demirci A., Cutter C. N. (2002): Comparison of electrolyzed oxidizing water with various antimicrobial interventions to reduce Salmonella species on poultry. Poultry Science, 81, 1598–1605.

Hara Y., Watanuki A., Arai E. (2003): Effects of weakly electrolyzed water on properties of tofu. Food Sci. Technol. Res., 9:332-337.

Kim C., Hung Y. C., Brackett R. E., Lin C. S. (2003): Efficacy of electrolyzed oxidizing water in inactivating Salmonella on alfalfa seeds and sprouts. Journal of Food Protection, 66, 208–214.

Komprda T., Zelenka P., Tieffova P., Stohandlova M., Foltyn J. (1999): Effect of the growth intensity on cholesterol and fatty acids content in broiler chiken breast and thigh muscle. The XIV European Symposium on the Quality of Poultry Meat, 19-23 September, Bologna, Italy, 1, 123-128.

Komprda T., Zelenka J., Fajmonová E., Bakaj P., Pechová P. (2003): Cholesterol Content in Meat of Some Poultry and Fish Species As Influenced by Live Weight and Total Lipid Content. Agric. Food Chem., 51 (26), 7692–7697.

Koseki S., Isobe S., Itoh K. (2004a): Efficacy of acidic electrolyzed water ice for pathogen control on lettuce. Journal of Food Protection, 67, 2544–2549.

Koseki S., Yoshida K., Kamitani Y., Isobe S., Itoh K. (2004b): Effect of mild heat pre-treatment with alkaline electrolyzed water on the efficacy of acidic electrolyzed water against Escherichia coli O157:H7 and Salmonella on lettuce. Food Microbiology, 21, 559–566.

Olteanu M., Criste R. D., Mircea E., Surdu I. (2010): Effect of Using Electrolysed Water of Layer Performance. The XIII European Poultry Conference, Tours, Franta, 23-27 august 2010, published in World's Poultry Science Journal, CD of Proceedings, EISSN no. 1743-4777.

Park C. M., Hung Y. C., Brackett R. E. (2002): Antimicrobial effect of electrolyzed water for inactivating Campylobacter jejuni during poultry washing. International Journal of Food Microbiology, 72, 77–83.

Ramanauskaite-Pogoreloviene (2006): The influence of using neutral anolyte (ANK) according to productivity of turkeys. Lithuania, Veterinarija ir Zootechnika. T, 33(55).

Russell S. M. (2003): The effect of electrolyzed oxidative water applied using electrostatic spraying on pathogenic and indicator bacteria on the surface of eggs. Poultry Science, 82, 158–162.

Yoshida K, Achiwa N., Katayose M. (2004): Application of electrolyzed water for food industry in Japan. Available at: http://ift.confex.com/ift/2004/techprogram/paper_20983.htm. Accessed August 2010.