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THE EFFECT OF THE LACTIC ACID ADDITION TO DRINKING WATER ON THE HYGIENE AND QUALITY OF CHICKEN BROILER MEAT

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Abstract. The objective of the study was to check whether the application of 0.4% lactic acid solution to chicken broilers during pre-slaughter handling causes a decrease in the bacterial contamination level of the meat and the technological meat quality. The study included 60 chicken broilers, Ross 308, which were subjected to pre-slaughter fasting for 12 hours. The birds were divided into two groups: the control, which was given clean drinking water, and the experimental group, which was given 0.4% lactic acid solution. Within 24 hours after the slaughter samples were taken from pectoral muscle in order to assess the total number of aerobic mesophilic microorganisms, *Salmonella* ssp. and *Campylobacter* bacteria. In the collected material the presence of the *Salmonella* ssp. and *Campylobacter* bacteria was not detected. The application of 0.4% lactic acid solution to chicken broilers 12 hours pre-slaughter showed a positive tendency to decrease the number of aerobic microorganisms in the chicken pectoral muscle. The mean number of the aerobic bacteria in the control group muscles was $5.2 \cdot 10^5$, whilst in the experimental group it was half the amount and was equal to $2.7 \cdot 10^5$. The lactic acid solution did not alter the technological meat quality.

Key words: chickens, lactic acid, meat quality, microorganisms, pre-slaughter handling

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INTRODUCTION

Live poultry carry various microorganisms, which live on its skin, feathers and inside the alimentary canal. The study carried out in 2009 by Maćkiw et al. [2011] showed massive contamination of raw meat and offals with thermotolerant *Campylobacter* bacteria. The research revealed that 50% of the meat samples collected from technological lines were contaminated by the bacteria.

Trawińska et al. [2006] claim that 58.59% of chicken carcasses from poultry processing plants in the province of Lublin, Poland, were contaminated with *Salmonella*. According to the European Food Health Authority, in 2008 *Salmonella* was present in 25% of chicken carcasses in Polish slaughterhouses [EPSA 2010]. The data shows that the problem of microbiological contamination of poultry is still present, which implies the necessity of its limitation. It is known that poultry contamination level depends on farming conditions, transport and pre-slaughter handling, as well as hygienic conditions in the slaughterhouses and production facilities [Szczawiński 1995, Lambooij et al. 1997, Wojtoń 1997, Gornowicz 2004].

In order to reduce contamination during chicken fattening, commonly probiotics [Chambers and Lu 2002, Janocha et al. 2010] and organic acids are used [Exit et al. 2006], including lactic acid [Gornowicz and Stachowiak 1996]. Probiotics and organic acids are considered to stabilise the development of physiological bacteria, and help in elimination of pathogenic microorganisms from alimentary canals through decreasing pH of intestine content [Faruga et al. 1993, Brzóska 2000, 2007, Zduńczyk 2002, EFSA 2010].

In the case of lactic acid, one of reports included application of 0.4% lactic acid solution to chickens during the pre-slaughter fasting period in order to eliminate the contamination of the carcasses surface by *Salmonella* spp. and *Campylobacter*, which revealed positive effects [Byrd 2001].

The present study aims to assess the effects of 0.4% lactic acid solution application to chicken broilers during the pre-slaughter fasting in terms of microbiological and technological meat quality.

MATERIAL AND METHODS

The study involved 60 one-week-old Ross 308 chicken broilers from the same poultry farm, kept and fed in the same manner. The chickens were divided into two groups: the control and the experimental one, 30 chickens each, sexes divided equally. During the pre-slaughter period, 12 hours prior to slaughter, the chickens in the control group were given clean drinking water, whereas those in the experimental group were given 0.4% lactic acid solution. After 12 hours, the birds were

transported to the poultry plant and slaughtered. Within 15 minutes following the slaughter, pH was measured using a combined glass electrode, ESAgP-306W, and a CyberScan 10 pH-meter (Eutech Cybernetics). Subsequently the carcasses were cooled down to 4°C, packed individually into plastic bags, transported to the laboratory and stored in 4°C.

After 24 hours' cooling, a sample was taken from each of the carcasses in order to assess the number of the *Salmonella*, *Campylobacter*, coliforms and aerobic bacteria cells, as well as coagulase-positive staphylococci. The microbial analysis was carried out following the procedures contained in Polish Standards (PN-ISO4832 1998, PN-EN-ISO6888-1 2001, PN-EN-ISO6579 2003, PN-ISO10272 2007, PN-EN-ISO4833 2013].

In samples dissected from the pectoral muscles (*m. pectoralis superficialis* and *m. pectoralis profundus*), the analysis included the sensory evaluation of the internal side of the muscles. The evaluation was carried out by a team of five people with proven sensory sensitivity [PN-ISO8586-1 1996, PN-ISO8586-2 1996]. The colour was assessed in a five-point scale: 1 point – very light meat, 2 points – light meat, 3 points – standard meat with balanced colour, 4 points – dark meat, 5 points – very dark meat.

Both kinds of the assessed muscles were then ground twice using a 4 mm net in order to carry out the following physicochemical tests:

- pH_{24} in the muscles was checked in the water extract (distilled water) after 1 hour extraction in 1:1 meat to water ratio;
- free water content (WL) was assessed with a balance with 0.001g uncertainty using Whatmann 1 paper, where 300 mg meat portions were weighed, then put between two glass plates and laden with 2 kg for approximately 5 min. The obtained contours of the stamped meat and the effluent were outlined with a pencil. After the papers dried the stains were planimetrated and on the basis of their surfaces difference, the surface of the effluent was calculated. Subsequently, the free water content (WL) was calculated using the Grau and Hamm method [1953] modified by Pohj and Niinivaar [1957].
- the instrumental colour assessment: the ground meat was placed into dishes suitable for the ground meat colour assessment and, after levelling, kept in 4°C for 20 min. Subsequently, the colour of the meat was assessed using a MiniScan XE Plus 45/0 apparatus according to the CIELAB [1976] D65 illuminate scale and a standard observer 10° [Honikiel 1998]. The apparatus standardisation was carried out according to the white and the black models with the parameters: = 78.5, Y = 83.3 i Z = 87.8 (for a D65 illuminate scale and a standard observer 10°).

The obtained results were analysed statistically using the STATISTICA 9 package and univariate ANOVA. The significance of differences was tested with the Duncan test at the significance level $P \leq 0.05$.

RESULTS

In the analysed samples there was no presence of *Salmonella* spp. i *Campylobacter* spp. observed, whilst the presence of *Staphylococcus* spp. (non-pathogenic strains) were recorded in three samples ($2.0 \cdot 10^2$; $2.8 \cdot 10^2$; $1.1 \cdot 10^3$ cells, Table 1). Also, the application of lactic acid to the chickens had no significant influence on the meat contamination with aerobic bacteria. In the samples from the experimental group, the mean number of this kind of bacteria was $5.2 \cdot 10^5$, whilst in the control group the amount was smaller by almost a half ($2.7 \cdot 10^5$). The minimum bacteria number in the control group equalled $2.0 \cdot 10^2$, and the maximum was $2.8 \cdot 10^6$. In the experimental group the amount of aerobic bacteria ranged from $5 \cdot 10^2$ to $2.8 \cdot 10^6$. The lactic acid addition had no significant influence on decreasing the levels of the pectoral muscle contamination with aerobic bacteria in chickens.

Table 1. The presence of pathogenic and aerobic bacteria in 1 g of meat in broiler chickens 24 hours after slaughter

Tabela 1. Liczba kolonii bakterii chorobotwórczych i tlenowych w 1 g mięśni piersiowych kurcząt brojlerów 24 godziny po uboju

Microorganisms Mikroorganizmy jtk/1 g	Control group Grupa kontrolna				Experimental group Grupa doświadczalna			
	mean	max.	min.	SD	mean	max.	min.	SD
Salmonella spp.	–	–	–	–	–	–	–	–
Campylobacter spp.	–	–	–	–	–	–	–	–
Staphylococcus aureus	–*	–	–	–	–	–	–	–
Staphylococcus spp.	–	–	–	–	–	–	–	–
Coliform bacteria Bakterie z grupy coli	–	–	–	–	–	–	–	–
Total number of aerobic bacteria Ogólna liczba bakterii tlenowych	5.2×10^5	2.8×10^6	2.0×10^2	1.0×10^3	2.7×10^5	2.8×10^6	5.0×10^2	8.0×10^2

jtk – colony forming cell.
jtk – jednostka tworząca kolonię.
**Staphylococcus* spp. was detected in three samples in the amounts of 1.1×10^3, 2.8×10^2, and 2.0×10^2.
*W 3 próbach wykryto obecność *Staphylococcus* spp. w ilości:$1,1 \times 10^3$, $2,8 \times 10^2$, $2,0 \times 10^2$.

The mean values of pH_{15} and pH_{24} were correct and equaled to 6.30 and 5.91, respectively, in the control group, and 6.29 and 5.80, respectively, in the experimental group. The meat from both control (2.93 points) and experimental (2.97%) groups had the required color, which was sensorically evaluated and confirmed with a spectrophotometer (Table 2).

Table 2. Physico-chemical evaluation of breast muscle of broiler chickens

Tabela 2. Ocena fizykochemiczna mięśni piersiowych kurcząt brojlerów

	Control group Grupa kontrolna	Experimental group Grupa doświadczalna	Total Ogółem
pH_{15}	6.30 ±0.20	6.29 ±0.20	2.95 ±0.20
pH_{24}	5.91 ±0.17	5.80 ±0.09	5.86 ±0.14
OSB (pkt)	2.93 ±0.32	2.97 ±0.39	2.95 ±0.35
OIB L*	52.98 ±2.70	53.72 ±2.63	53.35 ±2.66
a*	4.44 ±0.99	4.50 ±0.96	4.47 ±0.97
b*	10.14 ±0.94	10.56 ±1.04	10.53 ±1.00
Free water, % % wody wolnej (WL)	7.79 ±2.61	10.67 ±1.78	9.23 ±2.61

OSB – Sensory assessment of raw pectoral muscle in points.
OSB – Ocena sensoryczna mięśni piersiowych surowych w pkt.
OIB – Instrumental assessment of ground raw pectoral muscle.
OIB – Ocena instrumentalna barwy mięsni piersiowych surowych mielonych.

The meat water absorption was also correct in case of both groups. The mean free water content (WL) for the control group was 7.79% and for the experimental group – 10.67%.

There were no significant differences in any of the examined quality traits between the control and the experimental group (Table 2).

DISCUSSION

Salmonella and *Campylobacter* are two of the intestine pathogens associated with the cases of bacterial infections in gastrointestinal tract in humans [Daczkowska-Kozon 2005]. Chicken meat and poultry products appear to be the vectors of the bacteria. About 60% of poultry products contamination is caused by *Salmonella* and about 50–70% by *Campylobacter* [Pohja and Niinivaara 1957, Daczkowska-Kozon 2005]. Therefore, in order to ensure the consumer safety, it is essential to maintain the efficient production regime in the entire food production chain, from a farm to a ready product purchased by a customer. This justifies the continuous search for the ways of prevention of microbiological contamination in the early stages of production. One of such ways is to use organic acids as additives to animal feed or water during the poultry rearing. Abdullah et al. [2012] showed that the addition of 0.1% lactic acid solution to chickens drinking water during an 8-hour pre-slaughter fasting reduced meat *Salmonella* spp. contamination by 13%. Byrd [2001], who studied chickens from herds with various contamination levels, also claims that lactic acid addition to chickens drinking water decreases the in-

cidence of the carcass contamination with *Salmonella* spp. and *Campylobacter* spp.

The present study showed that the lactic acid addition to the chickens drinking water during the pre-slaughter fasting had a positive effect on decreasing the levels of aerobic bacteria in the carcasses.

In the present study, neither *Salmonella* spp. nor *Campylobacter* spp. were observed in the chicken muscles, which indicates good hygienic conditions of both the carcasses surface and meat.

The muscles of the chickens in the experimental group had less aerobic bacteria ($2.7 \cdot 10^5$) compared to the control group ($5.2 \cdot 10^5$, Table 1), however, the differences were statistically non-significant. It should also be emphasised that in both cases the amount of aerobic bacteria were within the acceptable limits for ground meat, according to PN-A–86527/A1 [1998], only in three samples (one from the experimental group and two from the control group) the number of the bacteria exceeded the maximum value and reached $2.8 \cdot 10^6$. Positive results in terms of decreased chicken broilers mortality and better health of herds were also observed by Gornowicz and Stachowiak [1996], whose study included applying 0.2% lactic acid solution to chickens on a long-term basis.

The results presented in this paper (Table 2) indicate a lack of significant influence of the lactic acid on the quality of meat of chicken broilers reared in normal environment conditions. This conclusion finds its confirmation in the results of the study by Majewska et al. [2009], who did not observe any significant influence of the lactic acid ($0.4 \text{ ml} \cdot 1^{-1}$) addition on the pH of the chicken pectoral muscle meat.

It may be concluded that the application of 0.4% lactic acid to chicken broilers 12 hours before slaughter does not deteriorate the technological quality of meat, however it does promote a decrease in contamination with pathogenic bacteria, which suggests higher microbiological safety and better stability.

CONCLUSIONS

1. In the examined chicken broiler meat, no presence of *Salmonella* ssp. or *Campylobacter* ssp was observed.
2. An application of 0.4% lactic acid solution to chickens 12 hours prior to slaughter tended to decrease the amount of aerobic microorganisms in the pectoral muscles of the chicken broilers.
3. An application of 0.4% lactic acid solution to chicken broilers during the 12 hour fasting did not significantly influence the technological quality of the meat.

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WPŁYW DODATKU KWASU MLEKOWEGO DO WODY PITNEJ NA STAN HIGIENICZNY I JAKOŚĆ MIĘSA KURCZĄT BROJLERÓW

Streszczenie. Celem pracy było sprawdzenie czy podanie 0,4% wodnego roztworu kwasu mlekowego kurczętom brojlerom w trakcie obrotu przedubojowego wpływa na obniżenie poziomu skażenia mięsa drobnoustrojami oraz technologiczną jakość mięsa. Przebadano 60 osobników kurcząt brojlerów Ross 308, które na 12 godzin przed ubojem poddano głodówce przedubojowej. Ptaki podzielono na grupę kontrolną która dostawała do picia czystą wodę oraz grupę doświadczalną której podawano do picia 0,4% wodny roztwór kwasu mlekowego. Dwadzieścia cztery godziny po uboju, z mięśni piersiowych tuszek kurcząt pobrano próby do określenia ogólnej liczby mezofilnych bakterii tlenowych i bakterii rodzaju *Salmonella* ssp. i *Campylobacter*. W przebadanym materiale nie stwierdzono występowania bakterii z rodzaju *Salmonella* ssp. i *Campylobacter*. Podanie kurczętom do picia 0,4% wodnego roztworu kwasu mlekowego na 12 godzin przed ubojem wykazało korzystną tendencję do zmniejszenia liczby drobnoustrojów tlenowych w mięśniach piersiowych kurcząt brojlerów. Średni poziom bakterii tlenowych w mięśniach kurcząt grupy kontrolnej wynosił $5{,}2 \cdot 10^5$, a doświadczalnej był prawie dwukrotnie niższy i wynosił $2{,}7 \cdot 10^5$. Zastosowanie wodnego roztworu kwasu mlekowego nie miało wpływu na jakość technologiczną mięsa.

Słowa kluczowe: głodzenie przedubojowe, jakość mięsa, kurczęta, kwas mlekowy, mikroorganizmy

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