WHEY AND LACTIC ACID IN BROILER CHICKENS NUTRITION

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Summary. Two experiments were conducted to determine the effect of undiluted fresh acid whey and lactic acid, offered as drinking liquid, on the production results of broiler chickens. In experiment I chickens were given undiluted fresh acid whey as drinking liquid twice a week for 4 hours. A starter diet offered to birds in this experiment was of poor quality. In experiment II chickens were given fresh acid whey or lactic acid in the amount of 4 cm^3/1 dm^3 (4 ml/l) water, also twice a week for 4 hours. In this experiment birds were offered starter, grower and finisher diets containing an acidifier. It was found that fresh acid whey given to chickens fed a poor-quality diet effectively prevented a drop in overall production results, contributing in particular to a decrease in mortality risk. In birds fed diets containing an acidifier, both whey and lactic acid had a negative effect on production results. Broiler producers should not use lactic acid or whey as drinking liquid if the feed offered to chickens is acidified with organic acids.

Key words: broiler chickens, feed additives, whey, lactic acid.

IŠRŪGOS IR PIENO RŪGŠTIS VIŠČIUKŲ BROILERIŲ MITYBOJE

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Santrauka. Atlikti du bandymai su viščiukais broileriais. Pirmojo bandymo metu, be švaraus geriamo vandens, viščiukai broileriai buvo girdomi šviežiomis išrūgomis du kartus per savaitę, keturių valandų laikotarpiu per dieną. Šios grupės viščiukų broilerių starteriniai kombinuotieji lesalai buvo nepakankamos maistinės vertės. Antruoju bandymu, taip pat per keturias valandas du kartus per savaitę, pakaitomis su geriamuoju vandeniu buvo duodamos šviežios išrūgos arba 4 cm^3/1 dm^3 (4 ml/l) pieno rūgšties. Šios bandomosios grupės viščiukų broilerių lesalai atskirais auginimo periodais buvo papildyti organinėmis rūgštimis. Bandymų metu nustatyta, kad nepakankamos maistinės vertės lesaluose šviežių išrūgų priedas teigiamai veikė viščiukų broilerių produktyvumą ir sumažino gaišimo riziką. Broilerių augintojai neturėtų naudoti pieno rūgšties ir išrūgų su geriamu vandeniu, jeigu lesalas buvo parūgštintas organinėmis rūgštimis.

Raktažodžiai: viščiukai broileriai, pašarų priedai, išrūgos, pieno rūgštis.

Introduction. Whey is produced in the process of milk acidification. Lactic acid bacteria break down lactose (milk sugar) into glucose and galactose, and then glucose is converted to L (+) lactic acid during lactic acid fermentation (Pijanowski, 1982). After 10 to 20 hours milk pH reaches 4.5. The acidic environment inhibits the growth of harmful bacteria, while beneficial lactic acid bacteria and digestive enzymes remain active. Lactic acid contributes to the absorption of vitamins D and K, and helps in the formation of soluble salts of calcium and iron. According to Schingoethe (1976) and Morishita et al. (1982), whey contains unidentified growth factors. Whey is considered an immune system enhancer, since its major protein fractions are α-lactoglobulin and β-lactalbumin. The yellow-green color of whey is due to the presence of B-group vitamins, in particular vitamin B_2. Rod-shaped lactic acid bacteria of the genus *Lactobacillus* are the most important type of friendly bacteria found in the digestive tract of birds. Therefore, its seems that acid whey may act as a natural probiotic in birds, enhancing their immunity, improving survival rates, and stimulating the growth of beneficial intestinal bacteria. The only problem is the fact that in contrast to mammals, birds lack the enzyme lactase (β-galactosidase) required to digest lactose. In birds lactose is hydrolyzed into glucose and galactose with the help of bacterial enzymes produced by *E. coli* (Barteczko, 1996). It follows that both the level and form of whey supplementation may significantly affect broiler performance.

The objective of this study was to determine the effect of undiluted fresh acid whey and lactic acid, offered as drinking liquid, on the production results of broiler chickens.

Materials and Methods. The study comprised two experiments. The birds were housed in floor pens on deep litter in an experimental unit of the experimental farm of the Department of Poultry Science of University of Warmia and Mazury in Olsztyn, Poland. Pelleted feed and water were offered ad libitum. Husbandry conditions conformed to the recommendations of the broiler breeder

company (Aviagen, 2007).

In experiment I, 480 day-old Ross 308 broiler chicks were divided into two groups, each of four replications of 30 males and 30 females. Chicks of both groups were fed commercial complete starter (20.0% total protein, 12.1 MJ ME) and finisher (18.0% total protein, 13.1 MJ ME) diets. The experimental factor was fresh acid whey obtained during cottage cheese production at the Department of Dairy Science and Quality Management, University of Warmia and Mazury in Olsztyn. Group I was a control group. Group II chickens were given undiluted fresh acid whey twice a week (on Tuesdays and Fridays) for 4 hours (from 8.00 a.m. to 12.00 noon). The body weights of birds were determined on day 17 and 42, feed intake was determined every week, and mortality rates were monitored on a regular basis. Chickens assigned to this treatment were unintentionally fed a starter diet of poor quality.

Due to the fact that the quality of feed used in experiment I was inadequate, another experiment was performed. In experiment II, 2250 unsexed Ross 308 broiler chicks were divided into three groups, each of five replications of 150 birds. Birds of all groups were fed the same commercial complete diets, in accordance with a three-phase feeding program. The diets contained organic acids as acidifiers (starter diet – 21.0% total protein, 12.1 MJ ME, grower diet – 19.0% total protein, 13.1 MJ ME, finisher diet – 18.0% total protein, 13.2 MJ ME). The experimental factors were whey and lactic acid, offered as drinking liquid. Group I was a control group. Group II chickens were given undiluted fresh acid whey, as in experiment I, and group III chickens received 50% lactic acid, diluted as recommended by the manufacturer (4 cm^3/1 dm^3 water). Whey and lactic acid were offered as in experiment I, i.e. twice a week (on Tuesdays and Fridays) for 4 hours (from 8.00 a.m. to 12.00 noon). Feed intake was determined every week, and mortality rates were monitored on a regular basis. The body weights of birds were determined individually on day 42, separately for males and females. At the end of the experiment 10 male broilers of each group (30 in total) were slaughtered to determine body parameters. After 12 hours of chilling, abdominal fat and skin with subcutaneous fat were removed from the carcass. Then breast muscles and legs were separated from the carcass and thigh and drumstick muscles were dissected separating meat from bones. The weights and yields of particular carcass parts were calculated (Ziołecki and Doruchowski, 1989). Cecal pH was measured immediately after slaughter, and the pH of the breast muscle (*m. pectoralis supreficialis*) was determined 24 and 48 hours post mortem, using a digital pH-meter with a glass electrode, type Eurosensor ESAgP-301.

The results of the experiment were analyzed using a one-way ANOVA test, and significant differences between groups were determined by Duncan's multiple range test. Statistica 8.0 for Windows™ software (StatSoft Inc., 2007) was used. Data in Tables are given as means ± standard deviations.

Results and Discussion. Experiment I. Mortality rates increased rapidly in both groups, control and experimental, in the second week of rearing (Table 1). This was most probably caused by the poor quality of feed offered to birds. The starter diet was found to contain anaerobic spore-forming rods, *Clostridium perfringens,* and molds, *Aspergillus penicillium,* whose counts exceeded 200 000 cfu/g feed. The diet was withdrawn on day 17, but until then mortality rates had already reached 30% in the control group (I). In group II, where chickens were given fresh whey to drink twice a week, mortality rates were threefold lower, at 8.75% (Table 1).

Table 1. **Mortality and morbidity of broiler chickens, %** (Experiment I)

Period, days	Groups	
	I - control	II - whey
Mortality		
1- 10	0.0	0.8
11-17	30.0	7.9
18-21	0.0	0.0
22-28	1.3	0.0
29-35	0.8	0.4
36-42	0.8	1.3
1-42	32.9	10.4
Morbidity		
18-42	10.0	5.8

Table 2. **Fattening performance of broiler chickens** (Experiment I)

Specification	Groups		SEM	*P*
	I - control	II - whey		
Body weight, kg				
17^{th} (males + females)	$0.210^{b} \pm 0.018$	$0.258^{a} \pm 0.021$	0.011	0.014
42^{nd}				
males	2.080 ± 0.130	2.170 ± 0.152	0.049	0.404
females	1.970 ± 0.106	1.993 ± 0.092	0.033	0.759
Feed conversion ratio, kg/kg	$2.333^{A} \pm 0.095$	$1.993^{B} \pm 0.102$	0.072	0.003

Values with different superscripts differ significantly; A, B - P≤ 0.01; a, b - P≤ 0.05

Feed of inadequate quality inhibited the growth of birds, but the addition of whey to diets exerted a beneficial influence. On day 17, i.e. directly after the withdrawal of the poor-quality feed, the average body weights of experimental group birds offered whey were approximately 25% higher, compared to the control group (Table

2). After the change of feed compensatory growth was observed in both groups, and eventually the difference in body weight between the control and experimental group diminished. The final body weights of males and females of the experimental (whey-supplemented) group were significantly higher, by 4.3% and 1.2% respectively, in comparison with the control group. Feed conversion was significantly better (1.99 kg/kg) in the whey-supplemented group, while in the control group feed consumption was significantly (by almost 15%) higher, reaching 2.33 kg per kg body weight gain. The considerable differences between the control and experimental group with respect to the values of performance parameters, observed in this experiment, could result from the poor quality of feed offered to birds. The prevailing opinion is that the effect of feed additives is directly proportional to feed quality – the worse the quality of feed, the more significant the effect of supplements. Gornowicz and Stachowiak (1996) fed diets with a 0.2% addition of 50% lactic acid to broiler chickens and noted a significant ($P<0.05$) positive effect of this feed supplement in diets containing no antibiotic growth promoters, in diets with increased concentrations of protein and fat, and in pelleted diets.

Experiment II. In both experimental groups, in which chickens were given whey and lactic acid to drink, production results were found to deteriorate (Table 3). Mortality rates were also higher in these groups, by approximately 1.5%, in comparison with the control group. The final body weights of males were lower, by 4.4% in group III and by 12.4% in group II, compared to the control group.

Table 3. **Fattening performance of broiler chickens** (Experiment II – 42nd day of age)

Specification	Groups			SEM	*P*
	I - control	II - whey	III - lactic acid		
Liveability, %	96.7	95.0	95.2	-	-
Body weight, kg					
males	2.844 ± 0.186	2.490 ± 0.183	2.718 ± 0.258	0.064	0.061
females	2.192 ± 0.133	2.110 ± 0.163	2.272 ± 0.143	0.039	0.257
Feed conversion ratio, kg/kg	1.963 ± 0.074	1.951 ± 0.100	1.959 ± 0.090	0.021	0.977

Table 4. **Slaughter analysis of broiler chickens**[1] (Experiment II)

Specification	Groups			SEM	*P*
	I - control	II - whey	III - lactic acid		
Body weight before slaughter (kg)	$2.849^{A} \pm 0.029$	$2.493^{C} \pm 0.022$	$2.715^{B} \pm 0.028$	27.650	0.000
Carcass weight (kg)	$2.136^{A} \pm 0.040$	$1.861^{C} \pm 0.035$	$2.034^{B} \pm 0.038$	22.122	0.000
Carcass yield (%)	75.0 ± 1.1	74.6 ± 1.16	74.9 ± 1.08	0.197	0.760
Breast muscles (%)	18.7 ± 0.9	18.9 ± 1.0	18.7 ±1.1	0.176	0.901
Thigh muscles (%)	$10.9^{A} \pm 0.6$	$9.8^{B} \pm 0.5$	$9.8^{B} \pm 0.5$	0.134	0.000
Drumstick muscles (%)	6.9 ± 0.3	6.9 ± 0.3	6.7 ± 0.3	0.061	0.301
Abdominal fat (%)	1.7 ± 0.3	1.5 ± 0.3	1.8 ± 0.3	0.054	0.197
Heart (%)	0.45 ± 0.04	0.42 ± 0.04	0.42 ± 0.04	0.008	0.197
Liver (%)	$1.98^{C} \pm 0.13$	$2.31^{B} \pm 0.24$	$2.63^{A} \pm 0.17$	0.059	0.000
Gizzard (%)	0.76 ± 0.08	0.74 ± 0.05	0.73 ± 0.08	0.012	0.608

Values with different superscripts differ significantly; A, B - $P \leq 0.01$; a, b - $P \leq 0.05$

[1] 10 male broilers per group (with average weight of each group), body weight before slaughter - 100%

The final body weights of females were lower only in the whey-supplemented group, by around 3.7%. This confirms the opinion that the efficacy of dietary supplementation with acidifiers, including whey and lactic acid, is low when homeostasis is maintained in the digestive system. Moreover, excessive supply of acidified feed may substantially decrease the pH of the digesta, thus inhibiting the activity of digestive enzymes and disturbing metabolic functions. In such a situation, lactic acid is not converted into propionic acid in the digestive tract, since the optimum pH for this conversion is around 6. Normally propionic acid is absorbed into the blood stream and is used as a source of energy; it is also involved in the synthesis of sugars and fats. An excessive drop in pH in the digestive system may result in rapid absorption of lactic acid into the blood, without prior conversion to propionic acid, which can cause serious health problems, severe diarrhea and, in extreme cases, even death (Schingoethe, 1976). Morishita et al. (1982) also reported that lactose (milk sugar) has a low energy value and is poorly assimilable in chickens, since their digestive system does not produce sufficient amounts of β-glucanase required for the hydrolysis of this sugar. Lactose contained in whey has purgative properties, which may lead to flatulence and diarrhea, as well as to a deterioration in production results. According to Kaneko et al. (2004), Pourreza and Alipour (2004), Buteikis et al. (2008), whey has no beneficial effect on the growth performance of broiler chickens, but in the experiments carried out by these authors chickens were fed whey-supplemented diets over the entire rearing

period. In a study conducted by Abu-Dieyeh et al. (2007), whey was mixed with drinking water at a rate of 0, 25, 50 and 75%, and offered to chickens every day, from 4. and 8. weeks of age. In the 25% whey treatment, the final body weights of broilers increased by 2.3%, whereas higher concentrations of whey (50 and 75%) decreased body weights by approximately 15 and 40% respectively. Other authors have demonstrated that feed additives should not be used on a non-stop basis and that intermittent supplementation is more efficient (Grela et al., 1995; Shariatmadari and Forbes, 2005).

In the present study whey and lactic acid were administered only twice a week, which nevertheless led to considerable liver enlargement, having no significant impact on carcass dressing percentage and carcass tissue composition (Table 4), and on the pH values measured in the breast muscles and blind guts of chickens (Table 5). The pH of meat ranged from 5.78 to 6.30, and it remained within the normal physiological limits for poultry meat (Szałkowska and Meller, 1998). The pH determined in the caeca of broiler chickens was at a similar level in all groups (6.65 – 6.90).

Table 5. **pH values of breast muscle and caeca content** (Experiment II)

Specification	Groups			SEM	*P*
	I - control	II - whey	III - lactic acid		
Breast muscle:					
pH_{24}	6.30 ± 0.17	6.23 ± 0.13	6.22 ± 0.15	0.027	0.432
pH_{48}	5.99 ± 0.19	5.92 ± 0.15	5.85 ± 0.20	0.034	0.251
Caeca:					
pH	6.90 ± 0.22	6.65 ± 0.34	6.68 ± 0.34	0.057	0.153

Conclusions

It has been concluded, based on the obtained results, that:

1. Fresh acid whey given twice a week to broiler chickens fed a poor-quality diet effectively prevented a drop in overall production results.
2. In chickens fed diets containing an acidifier, both whey and lactic acid had a negative effect on production results.
3. Broiler producers should not use lactic acid or whey as drinking liquid if the feed offered to chickens is acidified with organic acids.

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