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Use of drinking water acidification to enhance poultry performance in rural Thailand

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Abstract

Organic acids, and in particular formic acid and its salts are well known to improve productivity in animal nutrition. By acting against pathogens, they help to decrease pressure on the animal's immune system, thus more nutrients will be available for productive functions such as growth. Furthermore, securing a low pH in the gizzard and proventriculus, may improve protein digestibility. The use via the drinking water will therefore not only create hygienic conditions in the water itself, but also lead to improved performance parameters in the bird.

In a recent trial, conducted at a broiler farm in the Chonburi province, Thailand, drinking water acidification with a liquid acidifier consisting of formic acid and hexamethylenetetramine (ADDCON XL) was tested at two different dosage scenarios (1 ml/1000 ml for 7 h a day; 1ml/1000 ml for 20 h a day – both dosages for the last 24 days before slaughter) against a negative control. 13,500 birds were randomly selected and divided equally into 3 treatment groups with 4,500 chicks each. Feed and water were available *ad libitum*. The effects of the acidifier on performance (daily weight gain, feed conversion) and mortality was examined after 42 days. The results are given as mean and a confidence level of 95% was defined for these analyses.

Despite the short inclusion of the drinking water acidifier, average daily weight gain and feed conversion were improved significantly ($p<0.05$). Mortality remained below 5% in all groups without any differences between the groups. The European broiler index was highest in the group with 20 h access to the acidifier; however no statistics are available for this parameter.

This study demonstrates that including water acidification in broiler production has beneficial effects on the performance of the chicken and may be considered as a low-cost option to improve production parameters in general.

Introduction

The potential for organic acids to preserve feed and water quality lies in their ability to protect against microbial and fungal contamination and/or degradation. The free hydrogen proton of a dissociated organic acid lowers pH, thereby creating unfavourable conditions for bacterial pathogens. On the other hand, the undissociated form of organic acids directly penetrates the lipid membrane of Gram-negative bacterial cells. After entering cell cytoplasm at neutral pH, organic acids inhibit the bacteria's growth by inhibiting oxidative phosphorylation and causing increased energy expenditure (H^+-ATPase pump) (Lückstädt and Theobald, 2011).

Organic acids have been used in animal production for the past 50 years, mainly as additives in pig diet. In poultry, their application is relatively recent, with the earliest reports stemming from the late 1970's and early 1980's. One of the first reports of improved broiler performance with

organic acid supplementation was from Vogt et al. (1981), who used formic acid. From that time onwards, organic acids became more popular, whether to improve bird performance or to preserve feed from microbial degradation.
The presence of pathogenic bacteria in animal products such as poultry meat and eggs pose a serious threat to consumers. Salmonella for instance, ranks among the world's biggest threats to health. In the United States alone, the reported cases are responsible for around 580 deaths and an estimated 15,000 hospitalisations each year (WHO, 2005). It is estimated that cases of human salmonellosis in the USA, may vary from 2 to 4 million cases (Jones, 2011). A study reported by *World Poultry* in 2009, found that 79% of poultry drinking water samples were contaminated with Salmonella. Zimmerman (1998) reported a widespread occurrence of coliform bacteria in drinking water in the East and West coasts of the United States. Recommendations for poultry drinking water, according to Böhm (2000) are shown in Table 1.

Table 1: Drinking water guidelines for poultry - from Böhm (2000)

	Pathogen count (CFU)
Salmonella	0 CFU in 100ml
Campylobacter	0 CFU in 100ml
E. coli	0 CFU in 10ml
Total (37ºC)	<1,000/ml
Total (20ºC)	<10,000/ml

Environmental conditions play an important role in the recommendations, as bacterial growth can accelerate rapidly with increasing water temperature. In tropical poultry production systems, this can play an important role in determining whether a low level of bacterial contamination in the drinking water or feed can escalate quickly to impaired productivity in the poultry house.
Using organic acids in drinking water rather than feed has a number of advantages (Wales et al., 2010). The ability to apply acids through water during feed withdrawal periods is especially important during preslaughter, when birds' susceptibility to infection with bacterial pathogens may be increased (Ramirez et al., 1997; Byrd et al., 1998; Corrier et al., 1999). Organic acids in drinking water may also destroy or reduce any vegetative pathogens in the water. Acidifiers used via water can also be used strategically or throughout rearing, to suppress bacterial infections. Birds' water intake is roughly 1.5 to 2 times that of feed intake, so a lower dosage of acid via water can be used compared to feed to achieve the same dose within the bird. Acidifiers, however, are rapidly metabolised, so without the protection of the feed matrix, their efficacy only reaches the foregut, including crop, proventriculus and gizzard.
Organic acids, and in particular formic acid and its salts are well known to improve productivity in animal nutrition. By acting against pathogens, they help to decrease pressure on the animal's immune system, thus more nutrients will be available for productive functions such as growth. Furthermore, securing a low pH in the gizzard and proventriculus, may improve protein digestibility. The use via the drinking water will therefore not only create hygienic conditions in the water itself, but also lead to improved performance parameters in the bird.

Material and Methods

Drinking water was acidified with a liquid acidifier consisting of formic acid and hexamethylenetetramine (ADDCON XL) and tested at two different dosage scenarios (1 ml/1000 ml for 7 h a day; 1ml/1000 ml for 20 h a day – both dosages for the last 24 days before slaughter) against a negative control. 13,500 birds were randomly selected and divided equally into 3 treatment groups with 4,500 chicks each. Feed and water were available *ad libitum*.

Performance parameters (daily weight gain, feed conversion) and mortality were measured after 42 days. The results were analysed statistically and a confidence level of 95% was defined for these analyses.

Results and Discussion

Despite the short inclusion of the drinking water acidifier, average daily weight gain and feed conversion were improved significantly ($p<0.05$), as shown in Table 1. Average daily gain (ADG) was improved significantly at both 7 hours and 20 hours' treatment per day compared to control birds (47 and 48 v. 42 $g.d^{-1}$ respectively). Feed conversion ratio (FCR) was also improved by the acidification of the water (2.42 after 7 and 2.38 with $20h.d^{-1}$ acidification, respectively, compared to 2.58 in controls). Mortality remained below 5% in all groups without any differences between the groups. The European broiler index was highest in the group with 20 h access to the acidifier; however no statistics are available for this parameter.

Table 2: Comparison of broiler performance with or without access to acidified drinking water (1 ml per litre) from day 19 till day 42

	Control	**XL (7 h)**	**XL (20 h)**
42-d BW (kg)	2.28	2.38	2.42
ADG ($g.d^{-1}$)	42^{a}	47^{b}	48^{b}
FCR	2.58^{b}	2.42^{a}	2.38^{a}
Mortality (%)	1.0	1.1	0.9
EBI*	155	184	192

*EBI: European Broiler Index = ADG ×Survival / 10 ×FCR; Row means with different letter superscripts are significantly different at P<0.05

Acidification of the drinking water has previously been shown to have a positive effect on water quality and growth performance in broilers. Allen (1997) found that the addition of a minimum of 0.15% formic acid containing blend reduced Salmonella counts in drinking water to undetectable levels within 4 hours. Formic acid (0.5%) added to drinking water during a Salmonella challenge (10^{8}CFU), significantly reduced levels of the pathogen in the crop of broilers (during feed withdrawal), highlighting the value of use of an acidifier in drinking water during preslaughter, where feed withdrawal is a critical period for recontamination (Byrd et al., 2001).

The results of this study show improved productivity parameters (ADG, FCR, mortality and EBI) in broilers given acidified drinking water for either 7 or 20 hours per day. In a previous study (Parker et al., 2006), water acidification (0.08%) led to a significant improvement in FCR in broilers, a finding which was reinforced by the present study.

Conclusions and Outlook

The use of acidifiers in drinking water is a relatively recent development in poultry production. In tropical production systems, this may play a vital role in providing hygienic drinking water and reducing pathogen load, thus having enormous potential as an integral component of a successful biosecurity programme. The authors have used such additives under a wide variety of conditions in South and South East Asia. This particular study, carried out in Thailand, demonstrates that including water acidification in broiler production has beneficial effects on the performance of broilers and may be considered as a low-cost option to improve production parameters in general.

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