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Comparative Study Between Single Organic Acid Effect and Synergistic Organic Acid Effect on Broiler Performance

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Abstract: This study was conducted to compare the effects of single and synergistic organic acids (formic and propionic acids) on broiler performance. Three hundred one day-old mixed sexes broiler (Arbor-Acres) were divided into five groups of 60 birds each and randomly assigned to five treatment diets. A control group is considered where no added acids. Group 2 and group 3 are formed with 0.1 % formic acid and 0.2% propionic acid respectively. The forth group is formed with 0.3% organic acids (formic and propionic acids). Group 5 is formed by the addition of 0.3% biotronic acid. The results indicated that group 2, 3, 4 and 5 showed significantly higher ($p<0.05$) in average live weight, average daily gain, average daily feed consumption and mortality rate compared with the control group. Nevertheless at the same time treatment 4 showed significant decrease in the feed conversion ratio compared with other treatments.

Key words: Organic acids, propionic acid, formic acid, performance

INTRODUCTION

Organic acids have been used for decades in feed preservation, for protecting feed from microbial and fungal destruction or to increase the preservation effect of fermented feed, e.g. silage. In particular formic acid and propionic acid have been used extensively for this purpose (Nuria *et al.*, 2004).

Organic acids are considered to be any organic carboxylic acid including fatty acids and amino acids, of the general structure R-COOH. Not all of these acids have effects on gut microflora. In fact, the organic acids associated with specific antimicrobial activity are short-chain acids (C1-C7) and are either simple monocarboxylic acids such as formic, acetic, propionic and butyric acids, or are carboxylic acids bearing an hydroxyl group (usually on the alpha carbon) such as lactic, malic, tartaric and citric acids. Salts of some of these acids have also been shown to have performance benefits. Other acids, such as sorbic and fumaric acids have some antifungal activity and are short chain-carboxylic acids containing double bonds (Dibner and Buttin, 2002).

Organic acids are weak acids that are commonly found in fruit juices and fermented foods and that are added to foods as preservative agents (Lück and Jager, 1997).

Organic acids have increasingly and successfully been supplemented in feed in broiler production. The way of action of organic acids seems to be related to a reduction of pH in the upper intestinal tract, interfering with the growth of undesirable bacteria and modifying the intestinal flora (Kirchgessner and Roth, 1982).

The antimicrobial activity of organic acids is pH dependent. Organic acids have a clear and significant benefit in weanling piglets and have been observed to benefit poultry performance. Organic acids which are particularly effective against acid-intolerant species such as *E-coli, Salmonella and Campylobacter*.

Organic acid improve protein and energy digestibilities by reducing microbial competition with the host for nutrients and endogenous nitrogen losses, by lowering the incidence of subclinical infections and secretion of immune mediators and by reducing production of ammonia and other growth depressing microbial metabolites. Organic acids also improve the digestibility of proteins and amino acids and the absorption of minerals (Mroz *et al.*, 2000; Omogbenigun *et al.*, 2003), modulate endocrine and exocrine secretions and influence the mucosal morphology (Partanen and Morz, 1991).

Those acids have several additional effects that go beyond those of antibiotics. These include reduction in digesta pH, increased pancreatic secretion and atrophic effects on the gastrointestinal mucosa.

Acidification has the potential of controlling all enteric bacteria, both pathogenic and non pathogenic (Miller, 1987). Various organic acids including formic, fumaric, propionic and sorbic have been added to broiler feed resulting in positive response (Müjdat, 1999). These acids may enhance growth and feed efficiency by eliminating organisms that compete with the bird for nutrients, a benefit attributed to antibiotics. Several studies have suggested that the addition of organic acids such as formic or propionic acids to diets of chickens reduces the incidence of *Salmonella* on the carcass (Izat *et al.*, 1989).

The potential of single organic acids in feed preservation, protecting feed from microbial and fungal destruction, but also directly in the animal nutrition due to its effect on stomach pH and gut flora which is already known for decades and was proven in uncounted laboratory and field trials (Eidelsburger *et al*., 1994; Freitage *et al*., 1999). An increase in broiler performance due to the use of single acids was noticed for instance for formic acid (Vogt *et al*.,1981).

The aim of the present study was to evaluate the effect of single and synergistic organic acid on broiler performance.

MATERIALS AND METHODS

Three hundred one day-old mixed sexes broiler (Arbor-Acres) were divided in to five treatment groups of 60 birds each and randomly assigned to five treatment diets. The experiment was carried out in 42 days. Each treatment group was further sub-divided into two replicates of 30 birds per replicate. The chicks were fed with the starter diet (2850 Kcal ME/kg, 22.4% CP as fresh matter basis) for the first three weeks of the experiment. Consequently, they were fed on grower diet (2900 Kcal ME/kg, 20.2% CP as fresh matter basis) during the period of 3-5 weeks of the experiment. Meanwhile the finisher diet (3000 Kcal ME/kg, 18% CP as fresh matter carried out until the end of the experiment. The control group was given to the birds with out any additions. For other groups (T2, T3, T4 and T5) which are made by adding 0.1% formic acid, 0.2% propionic acid, 0.3% synergistic of formic and propionic acids and finally commercial product (Biotronic) in there respective order. Biotronic composed from mixture of formic and propionic by this way:

Formic	17.4%.
Ammonium formate	14.1%.
Propionic	12.4%.
Ammonium propionate	8.4%.
Filled material	47.7%.

The ingredient and the chemical composition of the diets presented in Table 1. They were analyzed using AOAC (1996) procedure. Feed and water were provided *ad libitum* during the experiment.

A photo period of 24 h/d in 4 weeks and 16 h/d in 4-6 weeks was maintained. Average body weight, body weight gain, feed intake, feed conversion ratio were recorded weekly. Mortality was recorded throughout of the experiment. At the end of the experiment the birds were 6 week old. They were slaughtered by cutting the throat and the jugular vein with a sharp knife near the first virtibrum. From each of the replicates 12 birds/group, were picked for eviscerating to calculate the dressing percent without edible giblets (heart, liver and gizzard) after recording their weight.

Data was analyzed using the General Linear Model procedure of SAS (SAS, Institute, 2002). Means were compared by the Duncan's multiple range test at 5% probability (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The effects of single and synergistic organic acids (formic and propionic acid) on broiler performance are presented in Table 2. At the end of the 6 weeks, average live weight and daily live gains differed significantly ($p<0.05$) between treatments. The highest live weight gain (2445.4 gm) was recorded for T3 which involves 0.2% propionic acid. This is followed by T2 (2424.9 gm), T5 (2378.6 gm), T4 (2375.8 gm). The control group T1 resisted 2186.8 gm of weight. These results do not agree with Izat *et al.* (1990) which indicated that added formic acid at the level 1% causes a decrease in live weight gain and so the case with Cave (1984) when he noticed the same reduction with 3% dose of propionic acid in the diet.

In this trial, the addition of acid (formic, propionic single or synergistic and Biotronic) to the diet resulted in broiler greater weights during the experimental period when compared with the control group, but no significant difference between treatments on any of the performance variable. The results obtained from the present study are in agreement with the results obtained by (Miller, 1987), who suggested that when chicks were housed in a clean environment organic acids or antibiotic supplementation were of no effect on performance. Several investigators reported that organic acids have positive effect on broiler body weight gain and feed conversion rate. This improvement was due to a decrease in the number of *coliforms* and *E-coli* in small intestine without any effect on intestinal pH (Izat *et al*., 1990). Thompson and Hinton (1997) observed a decrease in the amount of lactic acid in the crop when the concentrations of formic and propionic acids were increased, which suggested a decrease in lactic acid bacteria. This could be an explanation for the lower

Table 1: Composition of experimental diets in different periods of the experiment

Ingredient (%)	starter 1-3 weeks	Grower 3-5 weeks	Finisher 5-6 weeks
Yellow corn	58.0	64.0	70.0
Soybean meal (45% protein)	38.0	32.0	26.0
*Premix	3.0	3.0	3.0
Oil	0.5	0.5	0.5
Salt	0.3	0.3	0.3
Methionine	0.1	0.1	0.1
Lysine	0.1	0.1	0.1
Total	100	100	100
Composition			
ME (Kcal/kg)	2850	2900	3000
Crude protein (%)	22.4	20.2	18
Calcium (%)	0.13	0.23	0.31
Avail. Pho. (%)	0.17	0.16	0.15
Methionine + Cystine	0.80	0.75	0.71
Lysine	1.22	1.15	1.09

*Premix: (1%) provided the following (per kg of complete diets), 1400IU Vit. A, 3000 IU Vit. D3, 50mg Vit. E,4mg Vit. K, 3mg Vit. B6, 6 mg Vit. B12, 60 mg niacin, 20 mg pantothenic acid, 0.2 mg folic acid,150 mg choline, 4.8 mg Ca, 3.18 mg P,100 mg Mn, 50 mg Fe, 80 mg Zn, 10 mg Cu, 0.25 mg Co, 1.5 mg Iodine.

Table 2: the effect of single and synergistic organic acid (formic and propionic acids) on broiler performance

	Diets %				
Items	T1 control	T2 Formic acid 0.1%	T3 propionic acid 0.2%	T4 formic + propionic 0.3%	T5 Biotronic 0.3%
Average live weight (gm)	2229.8 ± 43.2^{b}	2467.9 ± 44.6^{a}	2488.4 ± 36.2^{a}	2418.6 ± 44.5^{a}	2421.6 ± 38.6^{a}
Average daily weight gain (gm)	2186.8 ± 43.1^{b}	2424.9 ± 44.6^{a}	2445.4 ± 36.2^{a}	2375.8 ± 44.5^{a}	2378.6 ± 38.6^{a}
Average daily feed consumption (g/bird/day)	108.4 ± 0.4^{b}	112.9 ± 0.2^{a}	114.1 ± 0.02^{a}	113.6 ± 0.2^{a}	110.3 ± 0.18^{a}
Feed conversion ratio (g feed/g gain)	1.97 ± 0.02^{ab}	1.93 ± 0.02^{bc}	1.85 ± 0.01^{c}	2.02 ± 0.07^{a}	1.83 ± 0.02^{c}
Mortality rate (%)	13.2^{a}	5^{b}	6.6^{b}	6.4^{b}	3.3^{b}
Dressing percent (%) without edible parts	68.1 ± 0.7^{c}	71.4 ± 1.4^{b}	76.3 ± 1.0^{a}	71.3 ± 1.0^{b}	70.8 ± 0.8^{bc}

$p\leq0.05$ (abc) mean values with different superscript within arrow differ significantly.

Table 3: The effect of adding organic acids (formic and propionic acids) on the Microbial balance in gastrointestinal tract

Treatment	Total count	Coliform	Lactobacillus
Control (T1)	10.22 ± 0.03^{a}	5.76 ± 0.02^{a}	1.5 ± 0.05^{d}
Formica acid (T2) 0.1%	9.56 ± 0.03^{c}	5.03 ± 0.05^{d}	2.63 ± 0.03^{a}
Propionic acid (T3) 0.2%	9.73 ± 0.02^{b}	5.33 ± 0.03^{b}	2.03 ± 0.03^{c}
Formic and Propionic acids (T4) 0.3%	9.76 ± 0.04^{b}	5.26 ± 0.04^{bc}	2.13 ± 0.03^{bc}
Biotronic (T5) 0.3%	9.66 ± 0.05^{b}	5.20 ± 0.01^{c}	2.23 ± 0.04^{b}

$p\leq0.05$ (abcd) mean values with different superscript within arrow differ significantly.

counts of *lactobacillus* spp. in the ileum of the crop exposed to the acidified litter. The formation finding agrees with Christian *et al.* (2004) which indicated that addition acidifiers containing well balanced acid combination can increase the growth of broiler chicken. Thompson and Hinton (1997) reported that the inclusion of formic and propionic acids in the form of Bio- add to the feed of hens made no difference to the pH of the intestinal tract, but resulted in high concentration of these acids in the crop contents, where bactericidal for *Salmonella* serotype Enteritis indicated that bird given organic acids were heavier than in treatment group.

Table 3 shows the effect of organic acids addition (formic and propionic) on the microbial balance in gastrointestinal tract. These results indicate that the addition of organic acids cause the reduction of total bacterial counts in different parts of the digestive tract; and also agree with the results of Al-Kassie and Abd-AL-Aljaleel, (2007) who used Galli acid and obtained a reduction in the total bacterial count in the crop, small intestine and caecae. The results are also in agreement with the results of Gauthier (2005) who suggested that the addition of organic acids cause a reduction of the bacteria in the colon. Total bacterial counts which are considered a sensitive bacteria for acidic media, have no such decreasing effects on the lactic acid bacteria which they cause a reduction in the pH.

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