

## EFFECTS OF FEEDING ORGANIC AND INORGANIC ACID BLENDS ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY IN YOUNG BROILER CHICKENS

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### SUMMARY

One hundred and ninety-six Ross chicks with an initial body weight of  $40.30 \pm 0.22$  g were used to study the effects of different crude protein levels supplemented with dietary organic and inorganic acids on growth performance and nutrient digestibility. The chicks were caged in pens of seven animals each, and had *ad libitum* access to feed and water. The chicks were divided into 4 groups: Control – 22% crude protein basal diet; T1: 22% crude protein basal diet + Orgacids<sup>TM</sup>; T2: 20% crude protein basal diet + Orgacids<sup>TM</sup>; T3: 18% crude protein basal diet + Orgacids<sup>TM</sup>. The apparent digestibility of crude protein, calcium and phosphorus was calculated using  $\text{TiO}_2$ . The birds fed with Control, T1 and T2 had better growth performance and feed conversion ratio than the T3. The diets added with acidifiers had better digestibility of crude protein, phosphorus and calcium. In conclusion, the chickens fed with Control, T1 and T2 had better weight gain than 18% CP with acid blends. However, similar growth performance was found between Control, T1 and T2. T1 and T2 had lower FCR than Control and T3. Better growth performance in Control, T1 and T2 is mainly attributed to the better digestibility of nutrients such as crude protein, phosphorus and calcium. There was a reduction of 17% SBM used in the diet when Control diet was compared with T2 diet.

Keywords: Organic acids, inorganic acids, growth, nutrient digestibility, chickens

### INTRODUCTION

Organic and inorganic acids have been used extensively as feed additive in livestock and poultry production (Partanen and Mroz, 1999; Izat *et al.*, 1989; Izat *et al.*, 1990). These acidifiers are used to enhance the growth efficiency of animals and can also be used to replace antibiotics as a growth enhancer in the feed of animals. This will directly reduce the incidence of development of resistance in human and animal pathogens due to excessive use of antibiotics in the diets. Many studies have been conducted to investigate the effects of organic acids on growth performance of animals (Roth and Kirchgessner, 1998; Risley *et al.*, 1991). Dietary supplementation with organic or inorganic acids or in combination has been shown to improve growth performance in animals (Zulkifli *et al.*, 2003; Sutton *et al.*, 1991) by providing an optimum pH balance and stimulating action on enzyme secretion throughout the gastrointestinal tract (Ravindran and Kornegay, 1993). The increase in enzyme secretion is expected to improve digestibility and availability of nutrients from feedstuffs. However, little is known regarding the nutrient digestibility of diet supplemented with organic and inorganic acids. Therefore, this study was conducted to determine the effects of different crude protein levels supplemented with dietary organic and inorganic acids on growth performance and nutrient digestibility.

### MATERIALS AND METHODS

A total of 196 male day-old Ross chicks with an initial body weight  $40.30 \pm 0.22$  g were used in the experiment. The birds were kept at 7 chicks per cage in an open house with an ambient temperature of 28-32°C. Water and feed were available *ad libitum* from day-old until 21 days of age. All the birds were individually wing-banded and vaccinated against Newcastle and infectious bronchitis disease via the intraocular route on day 1 and day 7. The starter diet was formulated to meet the nutrient requirements of broilers and was offered throughout the experimental period. The birds were randomly assigned to Control – Basal diet; T1: Basal diet (22% crude protein) + Orgacids<sup>TM</sup>; T2: Basal diet (20% crude protein) + Orgacids<sup>TM</sup>; T3: Basal diet (18% crude protein) + Orgacids<sup>TM</sup>. The organic and inorganic acid blend (Orgacids<sup>TM</sup>) was provided by Sunzen Corporation Sdn. Bhd., Malaysia.

The acid blends powder consisted of formic, phosphoric, lactic, tartaric, citric and malic acids. The inclusion rate of Orgacids<sup>TM</sup> was 0.15% (w/w). Table 1 shows the feed composition of experimental diets. The feed was formulated to be isocaloric but having different levels of calculated crude protein for all the diets. The treated diets were added with 0.3% titanium dioxide ( $\text{TiO}_2$ ) as indigestible marker during the last 5 days of experiment in order to calculate apparent digestibility.  $\text{TiO}_2$  was

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determined as described by Brandt and Allan (1987). Body weight was measured individually on a weekly basis. Weekly feed consumption was also recorded and feed conversion ratios were calculated. At the end of the experiment, all the birds were sacrificed and ileal digesta were collected. The feed and digesta were analysed for dry matter, crude protein (Kjeldahl method), phosphorus and calcium (AOAC, 1984). The phosphorus and calcium concentrations were determined by atomic absorption spectrophotometer. Results were expressed as mean  $\pm$  SEM. The data was analysed by one-way analysis of variance. Duncan Multiple Range Test (SAS, 1989) was used to compare the differences of means ( $P < 0.05$ ).

## RESULTS AND DISCUSSION

Table 1 shows the analysed nutrient contents of feed for broilers fed control, T1, T2 and T3. The crude protein levels were ranked in accordance to the soybean meal in the diets with the highest for the Control and lowest for the T3. Phosphorus and calcium were not significantly different ( $P > 0.05$ ) among the treatment groups. Table 2 shows the growth performance of broiler fed different dietary treatments. The initial body weight was not significantly different ( $P > 0.05$ ) between the treatment groups. The T3 had a significantly ( $P < 0.05$ ) lower final body weight compared with Control, T1 and T2. However,

**Table 1: Feed compositions of experimental diets**

Ingredients (%)	Control	T1	T2	T3
Corn	51.64	51.29	54.48	56.65
DL-Methionine	0.21	0.19	0.23	0.26
L-lysine	0.25	0.25	0.45	0.65
Limestone powder	0.67	0.67	0.67	0.67
Palm oil	6.00	5.98	6.00	6.20
DCP 20%P	2.39	2.38	2.43	2.49
Salt	0.04	0.04	0.04	0.04
Sodium bicarbonate	0.34	0.34	0.34	0.34
SBM Argentine 44%	38.10	38.00	31.50	25.50
Wheat pollard	0.00	0.35	3.35	6.69
Choline chloride	0.06	0.06	0.06	0.06
Mineral Mix	0.10	0.10	0.10	0.10
Vitamin Mix	0.10	0.10	0.10	0.10
Antioxidant	0.10	0.10	0.10	0.10
Orgacids <sup>TM</sup>	0.00	0.15	0.15	0.15
	100	100	100	100
<i>Calculated nutrients (%):</i>				
ME, kcal/kg	3,128.44	3,116.00	3,113.94	3,107.94
Protein	22.40	22.37	20.23	18.30
Fat	8.12	8.10	8.30	8.64
Fiber	3.58	3.60	3.59	3.62
Calcium	1.15	1.15	1.15	1.15
Total Phosphorus	0.84	0.84	0.84	0.85
Avail. P for Poultry	0.45	0.45	0.45	0.52
Salt	0.08	0.08	0.07	0.07
Arginine	1.49	1.48	1.30	1.14
Lysine	1.41	1.40	1.40	1.41
Methionine + Cystine	0.89	0.87	0.84	0.81
Methionine	0.55	0.53	0.53	0.53
Threonine	0.84	0.84	0.74	0.66
Tryptophan	0.28	0.28	0.24	0.21
<i>Analysed nutrients:</i>				
Crude protein	23.24 $\pm$ 0.31	22.87 $\pm$ 0.53	20.11 $\pm$ 0.12	18.32 $\pm$ 0.29
Calcium	0.65 $\pm$ 0.02	0.63 $\pm$ 0.03	0.66 $\pm$ 0.01	0.65 $\pm$ 0.01
Phosphorus	0.78 $\pm$ 0.03	0.82 $\pm$ 0.01	0.82 $\pm$ 0.03	0.87 $\pm$ 0.02

Mineral mix contains iron 80g/kg, manganese 100g/kg, copper 15 g/kg, zinc 80g/kg, iodine 1g/kg, selenium 0.2 g/kg, cobalt 0.25 g/kg, potassium 4g/kg, magnesium 0.6 g/kg and sodium 1.5 g/kg; vitamin mix contains vitamin A 50MIU/kg, vitamin D3 10 MIU/kg, vitamin E 75 g/kg, vitamin K3 10 g/kg, vitamin B1 10 g/kg, vitamin B2 30 g/kg, vitamin B6 20 g/kg, vitamin B12 0.10 g/kg, panthothenic acid 55.2 g/kg, niacin 200 g/kg, folic acid 5 g/kg and biotin 0.235 g/kg.

the final body weight for Control, T1 and T2 was not statistically significant ( $P>0.05$ ). The cumulative live weight gain and growth rate had similar trends as shown in final body weight. The supplement of acid blends had a positive effect on performance of the chickens in the diets with lower crude protein content. This enhanced response is related to better digestibility of crude protein as reported in Table 3. Better digestibility of crude protein could be related to higher activation of pepsin for protein digestion. However, this explanation requires further research.

The cumulative feed intake and daily feed intake were not significantly different ( $p>0.05$ ) among the treatment groups. However, the feed conversion ratio for T1 and T2 were significantly lower ( $p<0.05$ ) than T3. This result indicates that the birds from T3 convert the feed less efficiently compared with the Control, T1 and T2. The Control, T1 and T2 were not significantly different ( $p>0.05$ ) for feed conversion ratio. This shows that T2 fed 20% crude protein diet supplemented with acidifiers utilises the feed more efficiently. This could be explained by the activation of enzymes by acidifiers to improve digestibility.

Nutrient contents of digesta and apparent digestibility of broilers fed with Control, T1, T2 and T3 diets are shown in Table 3. The crude protein in the digesta for Control was significantly higher ( $p<0.05$ ) than the T2 and T3. No significant differences ( $p>0.05$ ) were found between Control and T1, and between T1, T2 and T3. Phosphorus in the digesta for T3 was significantly ( $p<0.05$ ) higher than the T1. There was no significant difference ( $p>0.05$ ) for the digesta phosphorus between Control, T1 and T2, and between Control, T2 and T3. The calcium content in the digesta for all the treatments was not significantly different ( $p>0.05$ ). The apparent digestibility of crude protein for Control was significantly ( $p<0.05$ ) lower than the T2 and T3. However, the apparent digestibility of crude protein for Control and T1 was not significantly different ( $p>0.05$ ). Similar findings were also noted between T2 and T3.

The apparent digestibility of phosphorus for Control and T1 was significantly lower ( $p<0.05$ ) than T2 and T3. However, no significant differences ( $p>0.05$ ) were found between Control and T1, and between T2 and T3. The apparent digestibility of calcium for T2 and T3 was significantly greater ( $p<0.05$ ) than the Control. There

**Table 2: Growth performance of broilers fed with control, T1, T2 and T3 diets**

	Control	T1	T2	T3
Initial body weight, g	40.14 ± 0.44	40.45 ± 0.39	41.45 ± 0.49	40.69 ± 0.43
Final body weight g	709.90 ± 13.70a	723.16 ± 9.68a	728.11 ± 9.61a	653.90 ± 11.10b
Cumulative live weight gain, g	670.00 ± 13.17a	681.65 ± 9.78a	692.18 ± 9.85a	613.10 ± 11.10b
Growth rate, g/day	31.87 ± 0.70a	32.48 ± 0.59a	33.03 ± 0.38a	29.18 ± 0.50b
Cumulative feed intake, g	990.00 ± 27.50	970.60 ± 28.30	981.70 ± 27.70	949.60 ± 10.10
Daily feed intake, g/day	47.14 ± 1.31	46.22 ± 1.35	46.75 ± 1.32	45.22 ± 0.48
Feed conversion ratio	1.48 ± 0.02ab	1.42 ± 0.02b	1.41 ± 0.03b	1.55 ± 0.03a

Cumulative feed intake, daily feed intake and feed conversion ratio were calculated based on per cage basis. The results are presented as mean±SEM. Values with different superscripts within rows differ significantly from each other at 95%.

**Table 3: Nutrient contents (dry matter basis) of digesta and apparent digestibility for broilers fed with control, T1, T2, and T3 diets.**

	Control	T1	T2	T3
Crude protein, %	12.13 ± 0.39a	11.42 ± 0.25ab	11.00 ± 0.29b	10.57 ± 0.25b
Phosphorus, %	0.47 ± 0.01ab	0.44 ± 0.08b	0.46 ± 0.08ab	0.48 ± 0.09a
Calcium, %	0.61 ± 0.03	0.73 ± 0.11	0.79 ± 0.07	0.83 ± 0.10
Apparent digestibility, %:				
Crude protein	59.84 ± 2.92c	65.62 ± 2.85bc	75.29 ± 0.96a	69.59 ± 2.46ab
Phosphorus	44.57 ± 4.22b	51.00 ± 4.10b4	68.53 ± 1.15a	61.71 ± 2.82a
Calcium	37.79 ± 4.74b	3.33 ± 6.83ab	56.09 ± 4.63a	52.04 ± 6.20a

The results are presented as mean±SEM. Values with different superscripts within rows differ significantly from each other at 95%.



was no significant difference ( $p>0.05$ ) between Control and T1. This finding was in agreement with the findings of Jongbloed *et al.* (2000) who reported that the apparent digestibility of Ca and P was significantly enhanced by the organic acids. Radcliffe *et al.* (1998) showed an improved phosphorus digestibility by using 1.5 or 3.0% of citric acid.

In conclusion, the chickens fed with Control, T1 and T2 diets had better weight gain than those fed 18% CP with acid blends. However, similar growth performance was found between Control, T1 and T2 even though T2 had lower CP level. T1 and T2 had lower FCR than Control and T3. Better growth performance in Control, T1 and T2 are mainly attributed to the better digestibility of nutrients such as crude protein, phosphorus and calcium. The study also shows that there was a reduction of 17% SBM used in the diet when Control diet was compared with T2 diet.

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