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Effect of Citric and Ascorbic Acids on Performance and Intestinal pH of Chicks[1]

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ABSTRACT An experiment was conducted to investigate the effect of one percent dietary citric and ascorbic acid additions on performance and intestinal pH of young chicks. The citric and ascorbic acid additions did not affect chick performance or pH of the duodenal lumen contents. Also, pH of the duodenal lumen contents was not affected by 1:2 to 1:8 dilutions with distilled water.

(*Key words:* chicks, citric acid, ascorbic acid, intestinal pH, performance)

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INTRODUCTION

Ascorbic acid and citric acid are both known to influence gut absorption. Ascorbic acid increases iron (Fe) absorption (Hungerford and Linder, 1983) and probably the absorption of other trace elements as well. Citric acid increases blood tetracycline levels compared with administration of oral tetracycline alone (Clary *et al.*, 1981; Pollet *et al.*, 1984). Citric and ascorbic acids may mediate these changes in gut absorption by contributing hydrogen ions to the intestinal milieu, which decreases the pH of the intestinal lumen contents.

The purpose of this investigation was to assess the effect of added dietary ascorbic and critric acids on performance and intestinal pH of chicks.

MATERIALS AND METHODS

Male Cobb chicks were used in this experiment. They were fed a corn-soybean meal diet (Table 1) from hatching to 4 days posthatching. After an overnight fast, the chicks were inspected for navel infection and fecal pasting, then weighed, wingbanded, and randomly assigned to treatments. The chicks were maintained on a 24-hr constant light schedule in a heated, thermostatically-controlled starter battery (mean temperature was 35 C) with raised wire floors.

The basal diet used in this experiment was a conventional corn-soybean meal diet formulated to meet the nutrient requirements of growing chicks (National Research Council, 1977). The basal diet (B), B plus 1% citric acid or B plus 1% ascorbic acid was fed to 3 replicates of 5 chicks each during the assay period 5 to 13 days posthatching. The experimental diets and tap water were provided *ad libitum*, and weight gain and feed consumption were determined on Days 6 and 8 of the assay period.

TABLE 1. *Composition of basal diet*[1]

Ingredient	(%)
Glucose·H_2O	to 100.00
Ground corn (8.6% CP)	46.14
Soybean meal (44.0% CP)	42.50
Vegetable oil	5.00
Alfalfa meal, dehydrated (17.0% CP)	2.00
Defluorinated rock phosphate	2.10
Oyster shell flour	.40
NaCl	.40
Vitamin premix[2]	.25
DL-Methionine	.15
$MnSO_4 \cdot H_2O$	.05
$ZnCO_3$	.01

[1] Contains 23.0% crude protein (CP).

[2] Provided the following per kilogram of diet: vitamin A, 6614 IU; vitamin D_3, 1653 ICU; vitamin E, 7 IU; vitamin B_{12}, 11 μg; riboflavin, 6.6 mg; niacin, 33.1 mg; d-pantothenic acid, 11.0 mg; choline, 551 mg; menadione, 1.5 mg; folic acid, .7 mg; pyridoxine, 1.1 mg; thiamin, 1.1 mg; d-biotin, 55 μg.

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TABLE 2. *Performance and intestinal pH of chicks fed excess dietary ascorbic and citric acids*

Treatment	Performance[1]		Intestinal pH[2]		
	Gain	Gain/feed	Day 6	Day 7	Day 8
	(g)	(g/kg)			
Basal (B)	145.5	.786	6.62	6.40	6.43
B + 1.0% ascorbic acid	142.0	.794	6.71	6.37	6.48
B + 1.0% citric acid	143.7	.797	6.66	6.41	6.54
Pooled SEM	3.0	.009	.12	.06	.15

[1] Data are means of three replicates of five male chicks each during the assay period 5 to 11 days posthatching; average initial weight of chicks was 76.0 g.

[2] pH determinations were made on one chick randomly selected from each replicate. The data are means of the three replicates on each of days 6, 7, and 8 of the experiment.

For pH measurement, on Days 6, 7, and 8 of the experiment, one chick from each replicate was randomly selected and then euthanized by cervical dislocation. The duodenal loop of the intestine was immediately excised and the contents rinsed into a test tube using a minimum volume of distilled water. Water remaining in the lumen was manually expressed into the test tube. Care was taken to avoid loss of intestinal contents and to prevent contamination with blood or bile. The suspension was immediately vortexed to a uniform consistency, and the pH was measured with an electronic pH meter and semimicro combination electrode suitable for *in vitro* diagnostic use (Beckman Model 4500, Corning 476050).

The intestinal contents were diluted approximately 1:4 for the pH determinations. A preliminary investigation was conducted to assess the effect of this dilution on intestinal pH. Duodenal lumen contents from six chicks were individually diluted 1:2, 1:4, and 1:8 with distilled water. Mean pH for the dilutions were 6.44, 6.54, and 6.66, respectively. The dilutions had no significant ($P>.10$) effect on pH of the lumen contents. A similar conclusion has been reported previously (Farner, 1942; Ruff *et al.*, 1974).

All data were analyzed by analysis of variance procedures (Steel and Torrie, 1981). Meaningful nonorthogonal single degree-of-freedom comparisons were used to test treatment differences. The pH determinations were analyzed statistically as described by Ruff *et al.* (1974).

RESULTS AND DISCUSSION

Results are presented in Table 2. The 1% citric and ascorbic acid additions did not ($P>.10$) affect rate or efficiency of gain on Day 6 of the experiment. Similarly, chick performance on Day 8 (with the 3 remaining chicks) was not affected by the dietary citric and ascorbic acid additions, Gain per chick and gain/feed values were 202.4, .736; 200.0, .722; and 205.6, .772 for the basal diet (B), B plus 1% ascorbic acid, and B plus 1% citric acid diets, respectively.[4]

The citric and ascorbic acid additions did not affect intestinal pH. Citric and ascorbic acid must therefore mediate intestinal absorption in a manner other than lowering the pH of the whole lumen contents. Hungerford and Linder (1983) concluded that ascorbic acid increased Fe absorption by maintaining Fe in a water-soluble form.

The results of this experiment also confirm earlier work demonstrating that pH of chick intestinal contents is not affected by minor dilutions with water (Farner, 1942; Ruff *et al.*, 1974). Dilution of duodenal lumen contents from 1:2 to 1:8 with distilled water did not significantly affect pH.

[4] Pooled SEM were 5.1 and .024 for gain and gain/feed, respectively.

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