RIOBOFLAVIN AND PANTOTHENIC ACID REQUIREMENT OF THE BROILERS THROUGH EIGHT WEEKS POSTHATCHING

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Story in Brief

One study utilizing 2,340 (Vantress x Arbor Acre) broilers was conducted to evaluate the NRC riboflavin and pantothenic acid requirement for growth. Parameters monitored include pantothenic acid tissue concentration and blood GSH-Reductase. Birds were randomaly divided into 60 pens at hatching. Treatments evaluated were as follows: 1) basal diet lacking both pantothenic acid and riboflavin; 2) NRC recommandations for both vitamins; 3) as 2 with 2 x NRC supplemented riboflavin; 4) as 2 with 4 x NRC supplemented riboflavin; 5) as 2 with 2 x NRC supplemented pantothenic acid; 6) as 2 with 4 x NRC supplemented pantothenic acid; 7) as 4 and 6 in combination. Pectoralis major and blood samples were collected at eight weeks for pantothenic acid and GSH-Reductase analysis, respectively. Live weight gain and survival were depressed at four weeks when pantothenic acid and riboflavin were deficient. However, no sign of muscle weakness or leg paralysis was observed. Blood GSH-Reductase was not impacted by dietary riboflavin level while growth rate was increased by 6% at 56 days posthatching when dietary riboflavin was increased. However, increasing pantothenic acid elevated tissue concentration of pantothenic acid by 35% and 74% with no impact on growth rate. The data suggests that NRC recommandations of 10 ppm for pantothenic acid are satisfactory for growth while the 3.6 ppm for riboflavin requires further investigation.

(Key Words: Pantothenic Acid, Riboflavin, Growth, Tissue Concentration, GSH-Reductase.)

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Introduction

The importance of dietary pantothenic acid and riboflavin for most poultry classes is well established (Lepkovsky and Juke, 1936; Bauernfeind and Norris, 1939; Gillis et al., 1942). The National Research Council (1984) has established the requirement for pantothenic acid at 10 ppm and at 3.6 ppm of diet for riboflavin. Typical corn-soybean meal rations for starting to growing broilers contain from 5.59 to 5.06 ppm of patothenic acid and 2.69 to 2.5 ppm of riboflavin of feed and as a result must be supplemented.

Pantothenic acid deficiency in rats and chickens has been observed to reduce growth (Nelson and Evans, 1946; Cupo and Donaldson, 1986) and vitamin content of tissue (Snell et al., 1940). Bauernfeind et al. (1942) reported that Rhode Island Red chicks are less susceptible to pantothenic acid deficiency and require less amount of the vitamin than layers.

The dietary riboflavin needs of broilers varies with age, growth, genetic background, stage of production, and ration compostion criteria. Bolton (1944) reported that the minimum requirement of 3.0 ppm is optimum for the broiler until six weeks of age and the leg problem associated with the riboflavin deficiency is preventable with 3.6 ppm of the vitamin. Ogunmodede (1977) reported that 5.1 ppm dietary riboflavin is the optimum level for maximizing broiler's body weight. However, McDowell (1989) noted that chickens riboflavin requirement is positively correlated with consumption of rations containing high levels of fat and protein. Turkki and Holtzapple (1982) reported that increased riboflavin requirement is related to the growth rate rather than protein intake. The importance of riboflavin for maintaining enzyme functions such as glutathione (GSH) reductase is well established (Beutler, 1975). Bamji (1969) has shown that activity of GSH decreases in humans consuming suboptimal riboflavin levels.

The purpose of the research described herein was to evaluate the dietary pantothenic acid and riboflavin requirement established by the NRC for adequacy to promote optimal broiler growth rate, feed efficiency, survival, and carcass composition as well as observe the impact of supplemental vitamin levels on tissue pantothenic acid concentration and lysed red blood cell rate of reaction of GSH-reductase.

Materials and Methods

Two-thousand-three-hundred-forty male broilers (Vantress x Arbor Acre) were divided and randomly allotted at hatching into 60 pens such that each pen contained 39 chicks (.8 ft^2/bird). Treatments evaluated were as follows: 1) basal diet containing no supplemental riboflavin or pantothenic acid; 2) as Treatment 1 with vitamins supplemented to met the NRC recommendations of

3.6 ppm of riboflavin and 10 ppm of pantothenic acid; 3) as Treatment 2 with vitamin supplementation such that the riboflavin level was 2 x NRC recommendations; 4) as Treatment 2 with vitamin supplementation such that the riboflavin level was 4 x NRC recommendations; 5) as Treatment 2 with pantothenic acid supplemented to 2 x NRC recommendation; 6) as Treatment 2 with pantothenic acid supplemented to 4 x NRC recommendation and 7) as Treatment 2 with both riboflavin and pantothenic acid supplemented to 4 x NRC recommendations. Basal ingredients (Table 1) were analyzed for riboflavin (2.69 ppm) and pantothenic acid (5.59 ppm) content to ensure accurate fortification levels. Due to pen limitations Treatments 1, 3, and 5 had eight replications per treatment while the other treatment groups had nine.

Birds were provided drinking water and starter (weeks 1-4), and grower (weeks 4-8) rations (Table 1) for ad libitum consumption during the experiment. Body weight and feed consumption were tallied by gravimentric analysis at four and eight weeks posthatching. Two chickens per pen were selected upon completion of week 8 for carcass dressing percentage, liver weight, gizzard weight, and fat pad determination. One bird was selected from each pen, the pectoralis major (breast muscles) were removed wrapped in aluminium foil and frozen at -20°C for pantothenic acid analysis AOAC (1984).

Table 1. Basal ration formulation.

Ingredient	Starter ration, %	Grower ration, %
Corn	45.43	53
Soybean meal	42	37
Fat	6.3	6.5
DiCalcium phosphate	2.35	1.61
Calcium carbonate	1.2	1.23
Salt	.4	.4
Vitamin mix[1]	.2	.2
Trace elements[2]	.1	.1
DL-methionine	.25	.2
Fish meal	1.90	

[1] Mix supplied Vit. A, 14,109 I.U.; Vit. D_3, 5291 I.U.; Vit. E, 47.62 I.U.; Vit. B_{12}, .014mg; Riboflavin, 8.82 mg; Niacin, 26.5 mg; d-Panthothenic Acid, 28.2 mg; Choline, 705.5 mg; Menadione, 1.16 mg; Folic Acid, 1.76 mg; Pyridoxine, 3.52 mg; Thiamine, 3.52 mg; d-Biotin, .176 mg (per kg of diet).

[2] Mix supplies manganese, 120 mg; zinc, 80 mg; copper, 10 mg; iodine, 1 mg; calcium, 180 mg (per kg of diet).

Blood samples were collected from the bracial vein upon completion of week 8 for glutathione reductase analyses. The analytical technique utilized was modified from Beutler (1975).

Results and Discussion

Live weight gain and survival (P<.05) were depressed at four and eight week posthatching (Table 2) when both the riboflavin and pantothenic acid vitamin supplements were deleted from the basal ration. However, the basal corn-soy diet containing 2.69 ppm riboflavin and 5.59 pantothenic acid was sufficient to prevent deficiency symptoms such as perosis, dermatitis, and curled-toe-paralysis similar to other studies (Bird et al., 1946; Scott et al., 1982). The resultant growth rate and survival reductions cannot be attributed specifically to pantothenic acid or riboflavin since the basal ration fell below NRC recommendations for both vitamins.

The NRC dietary recommendation of 10 ppm pantothenic acid of ration appears adequate for maximal weight gain, feed efficiency and survivability throughout the 8-week growth period examined in this study.

Despite the differences in pantothenic acid supplementation, tissue concentration of the vitamin did also increase (P<.05) with an increase in dietary vitamin supplementation (Table 3). This data indicates that there is no significant difference between tissue concentration of dietary supplemented Treatment 1 (5.59 ppm) vs Treatment 2 (10 ppm).

In spite of the lack or excess vitamin supplementation there was not a significant effect on dressing percentage, liver, gizzard, and fat pad expressed as a percent body weight (Table 3).

Table 2. The effect of riboflavin and pantothenic acid supplementation on body weight and feed efficiency.

Treatment	28 Days	Feed efficiency	56 Days	Feed efficiency
1	1.88^{b}	.50	6^{c}	.44
2	2.05^{a}	.53	6.05^{a}	.42
3	2.10^{a}	.53	6.42^{b}	.44
4	2.07^{a}	.54	6.28^{bc}	.43
5	2.05^{a}	.52	6.09^{ac}	.43
6	2.04^{a}	.54	6.07^{ac}	.45
7	2.06^{a}	.54	6.20^{ac}	.43

^{a,b,c} Means in the same row with different superscripts differ (P<.05).

Table 3. The effect of riboflavin and pantothenic acid on carcass composition.

	Treatment						
	1	2	3	4	5	6	7
Change in A_{340} / time (min)	.034	.036	.040	.040	---	---	.047
Pantothenic acid PPM	11[c]	11.3[c]	---	---	15.3[b]	19.7[a]	18.8[a]
Dressing, %	.69	.68	.68	.69	.69	.68	.69
Liver as % body weight	2.39	2.30	2.40	2.42	2.34	2.52	2.32
Gizzard as % body weight	2.30	2.35	2.46	2.30	2.26	2.42	2.41
Fat pad, %	2.28	1.77	2.13	1.98	2.10	2.20	2.37

[a,b,c] Means in the same row with different superscripts differ (P<.05).

Brady et al. (1979) reported that in rats, 2 ppm supplementation of riboflavin was adequate to increase weight gain to that observed in rats fed 4 and 10 ppm. While for broiler chickens Ruiz and Harms (1988) reported that 2.6 ppm of riboflavin resulted in leg paralysis and recommended 4.6 ppm riboflavin. In contrast to earlier finding, the basal diet containing 2.6 ppm of the vitamin did not show sign of leg paralysis due to riboflavin deficiency. While the suggested NRC level of 3.6 ppm of riboflavin in the diet seems to be adequate in order to prevent poor growth through four weeks posthatching, beneficial effects of additional riboflavin were noted at week eight. The riboflavin requirement should be increased after four weeks of age to maximize growth (Table 2).

Riboflavin deficiency has been reported to decrease the erythrocyte activity of GSH-reductase Bamji (1969). Bamji and Sharada (1972) reported that 28 days after initiation of a riboflavin deficient diet the erythrocyte GSH-reductase activity was lowered in rats. Brady et al. (1979) reported that the erythrocyte percent active-GSH plateaued between 2 and 4 ppm of diet. However, since all the treatments were fed levels which met the minimum dietary riboflavin requirement therefore the rate of reaction based on a change of absorbance of NADPH to NADP at 340 nm over time and overall NADPH utilization by the lysed RBC's GSH-reductase was not changed by the increase in dietary riboflavin supplementation (Table 3).

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