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A STUDY ON HYPERVITAMINOSIS-A IN BROILER CHICKEN

BY

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INTRODUCTION

High levels of dietary vitamin A was found to reduce growth rate and food consumption in chicken (Nieman and Eleinblink, 1954). Toxic effects of vit A has been reported in chicken by Don and Ballom (1976) and Stevens et al. (1983). However, other investigators demonstrated that healthy chicken can tolerate high levels of vit. A without showing signs of toxicity (Pudelkiewicz et al., 1964; McGuaig and Motzok, 1970).

Feeding a ration containing a high source of vit. A was associated with decreased B carotene and other carotenoids absorption (Dua et al., 1966) and a reduction in tissue carotenoids pigments (Mattson and Deuel, 1943). Reductions in cholesterol absorption and in yolk cholesterol were also reported in vit. A treated birds by March & Biely (1963) and Hashish and El-Husseiny (1984), respectively. On the other hand, high dietary vit. A was associated with increased biosynthesis of triglycerides by chicken (Squibb, 1963), and with reduced biosynthesis of phosphatidyl choline (Ram and Misra, 1979).

The purpose of the present study was to examine the effects of increased levels of vit. A mixed with diet, or administered orally or intramuscularly (i.m) in growing broiler chicken.

MATERIALS AND METHODS

One-day old commercial broiler chicks obtained from a local hatchery were admitted to the experimental room, reared on litter under standard environmental conditions and fed balanced basal broiler ration.

Experiment 1:

At the age of 6 days chicks were divided into two groups, of 25 birds each. The control group was maintained on basal ration through out the experimental period, whereas the treated group received the basal ration containing different levels of vitamin A palmitate (165 µg/ml) (Roche, Switzerland). Based on the dose of vit. A and the time course of treatment, the experimental period was divided into 4 treatments, of 10 days each. In treatment 1 of the experiment all treated chicks received 200,000 IU/kg diet from age 7-16 days. Then the level of vit. A was increased to 400,000 IU/kg ration from age 17-26 days (Trt. 2). Vitamin A was withdrawn from the ration fed to the birds at age 27-36 days (Trt. 3), then resumed in Trt. 4 at a level 400,000 IU/kg ration from age 37-46 days.

Experiment 2:

A batch of 10 days old broiler chicks were randomly divided into 3 groups: a control group composed of 20 birds, and two treated groups, of 15 chicks each. Instead of giving vit. A mixed with ration as in experiment 1, treated group of this experiment received single daily doses of various levels of vitamin A either orally or i.m. This experiment is divided into 2 treatments: in the first, one treated gorup (Trt. AI) received single oral doses of vit. A(8,000 IU/bird/day), while the other group (Trt. BI) was injected with the same dose of the vitamin i.m. in the pectoral muscle. After a period of 10 days,

treated groups received another single doses of vit. A (16,000 IU/bird/day) either orally (Trt. A2) or i.m. (Trt. B2) for another 10 days period. During the entire experimental period all groups were maintained on the same balanced ration.

Calculation of the doses of vit. A in this experiment was based on the crude estimation of the daily amount of vit. A mixed with ration consumed by each bird.

At the end of each treatment of both experiments 5 chicks were removed from control and each treated group. After recording body weights, chicks were sacrified by cervical dislocation. Blood samples were collected by cardiac puncture in heparinized tubes, centrifuged at 3,000 rpm/10 minutes, and the collected plasma were stored at -20°C for chemical analysis. Liver was removed as soon as possible, plotted dry, weighed and stored at -20°C for further analysis.

Analytical Procedures

Plasma levels of vit. A and B-carotene was assayed colorimetrically following the procedure of Neeld and Pearson (1963). Vitamin A palmitate was used for the preparation of stock standard solution. Liver concentration of vit. A was assayed using a colorimetric assay described by Hickman (1937) as modified by Shemet (1978).

Statistical Analysis

Data were subjected to either Student's t-test for two group comparison) or one-way analysis of variance (ANOVA) using a significance level of $P < 0.05$. Specific group differences were determined using Duncann's test.

RESULTS

No significant changes in body and liver weights were observed in chicks fed vit. A-added diet (Table, 1). On the other hand, chicks received vit. A by i.m. injections showed significant reductions in body wt. accompanied by similar reduction in total liver Wts. Tabel, 2).

Measurement of plasma B-carotene levels in healthy control chicks revealed a drastic decline at age 26 days followed by progressive increases for the rest of experimental period (Table, 3). Treatment with different levels of vit. A, whether added to the ration or administered parenterally induced significant reductions in plasma levels of B-carotene in chicks (Tables 3, 4), which reached zero values in vit. A-injected birds (Table, 4). Withdrawing vit. A from the ration did elevate plasma level of B-carotene, but still was significantly lower than control (Table, 3).

An increase in plasma level of vit. A was observed in chicks following the addition of the vitamin to the ration. This significant increase disappeared upon the withdrawal of vit. A from the ration and observed again when the diet was supplemented with the vitamin (Table, 3). Daily oral doses of vitamin A also induced a significant elevation of its plasma level compared with the control group (Table, 4). However, when the same group received another dose of vit A, although higher than the first one, the plasma level of vit. A maintained a normal value. Neither the first daily i.m. doses of vit. A, nor the second higher doses were associated with elevation of the vitamin's plasma level in comparison with the controls (Table, 4).

Vitamin-A supplemented ration induced significant increases in the levels of vit A in the liver of

Table 1. Effects of feeding different levels of vitamin A on body and liver weights of growing chicks

Group	Age (days)	Body Weight(g)	Liver Weight (g)
Control	16	106.1 ± 9.4	3.8 ± 0.2
Treatment 1		130.8 ± 21.6	5.4 ± 0.7
Control	26	399.8 ± 25.0	14.2 ± 0.8
Treatment 2		392.1 ± 13.2	13.8 ± 0.6
Control	36	646.6 ± 33.9	22.3 ± 0.7
Treatment 3		651.4 ± 66.5	22.2 ± 2.3
Control	46	961.6 ± 60.9	34.4 ± 1.1
Treatment 4		986.8 ± 67.7	33.7 ± 2.1

Values are presented as mean ± SD

Treatment 1: Chicks received vit. A (200, 000 IU/kg ration) from age 7 - 16 days (5 birds were killed at the end of it).

Treatment 2: The rest received an increased dose of vit A (400,000 IU/kg ration) from days 17-26 (another 5 birds were killed by the end of this period).

Treatment 3: From days 27-36 the remaining chicks received no vitamin A but only standard ration (5 birds were also killed by the end of this period).

Treatment 4: The period extending from days 37-46 the chicks resumed receiving vit A (400, 000 IU/kg ration) and at the end of it 5 birds were sacrified.

Table 2. Effects of different levels and routes of administration of vitamin A on body and liver weights of growing Chicks.

Group	age (days)	Body Weight (g)	Liver Weight (g)
Control	20	154.1 ± 7.5	6.7 ± 0.5
Treatment A1		160.8 ± 11.2	6.9 ± 0.4
Treatment B1		121.4 ± 13.9 *	5.7 ± 0.7*
Control	30	366.5 ± 28.3	14.4 ± 1.1
Treatment A2		376.0 ± 29.6	13.9 ±7.4
Treatment B2		258.4 ± 49.3*	10.7 ± 1.2 *

Values are presented as mean ± SD

* $P < 0.05$, significantly different from control.

Treatments: at the age of 10 days chicks received a single dose of vitamin A (8,000 IU/chick) either orally (Trt. A1) or intromuscularly (Trt B1), and 10 days later 5 chicks were sacrified from each group.

The rest of chicks from each group received another single dose of increased level of vitamin A (16,000 IU/chick) orally (Trt. A2) or i. m. (Trt B2), and 5 chicks were sacrified from each group 10 days later.

Table 3: Effects of feeding different levels of vitamin A on plasma levels of B-carotene and vitamin A, and on liver content of vitamin A in growing chicks.

Group	Age (days)	Plasma B-carotene (µg/100 ml)	Plasma vit. A (µg/100 ml)	Liver vit. A µg/g (w/w)
Control	16	238.1 ± 57.6	38.1 ± 3.3	31.4 ± 2.7
Treatment 1		112.5 ± 46.4*	96.4 ± 11.9*	221.0 ± 32.1*
Control	26	10.0 ± 3.2	36.2 ± 3.7	14.6 ± 0.9
Treatment 2		2.5 ± 2.5*	102.7 ± 6.8*	335.7 ± 1.4*
Control	36	333.5 ± 96.9	50.6 ± 6.5	32.5 ± 4.4
Treatment 3		175.0 ± 73.1*	43.5 ± 5.3	496.8 ± 7.0*
Control	46	557.0 ± 100.9	55.8 ± 7.2	62.9 ± 5.3
Treatment 4		49.5 ± 25.9*	74.1 ± 7.1*	379.1 ± 38.9*

Values are presented as mean ± SD

* $P < 0.05$, significantly different from control.

The description of each treatment is presented in Table 1.

Table 4: Effects of different levels and routs of administration of vitamin A on plasma levels of B-carotene and vitamin A, and on liver content of vitamin A in growing chicks

Group	Age (days)	Plasma B-corotene (µg/100 ml)	Plasma vit.A (µg/100 ml)	Liver vit. A µg/g (w/w)
Control		74.2 ± 52.9	24. 7 ± 4.9	15.1 ± 1.5
Treatment A1	20	16.9 ± 9.9*	122.6 ± 17.8*	112.6 ± 27.4*
Treatment B1		Zero	44.2 ± 3.2**	74.2 ± 15.7*,**
Control		361.2 ± 73.7	39.8 ± 3.3	13.0 ± 1.2
Treatment A2	30	13.7 ± 9.9*	40.5 ± 2.1	166.4 ± 31.1*
Treatment B2		Zero	46.1 ± 8.8	201.0 ± 43.3*

Values are presented as mean ± SD

* $P < 0.05$, significantly different from control.

** $P < 0.05$, Significantly different from Treatment A.

Each treatment is described in detail s in Table 2.

Table 5. Plasma Cholesterol levels in vitamin A treated growing chicks.

Experiment	Age (days) 16	26	36	46
Control	105.7 ± 11.5	145.3 ± 4	130.2±12.8	105.2 ±
Treatment 1	101.9 ± 8.6			
Treatment 2		140.4 ± 4.8		
Treatment 3			105.8 ± 8.9*	
Treatment 4				78.9 ±

Experiment 2	Age (days) 20	30
Control	81.5 ± 6.6	93.7 ± 6.3
Treatment A1	68.7 ± 4.7	
Treatment B1	71.1 ± 8.6	
Treatment A2		98.0 ± 7.6
Treatment B2		76.3 ± 13.4

Values are presented as mean ± SD

* $P < 0.05$, significantly different from control.

Treatments of experiments 1 and 2 are described in details in Table 1 and 2, respectively.

growing chick during the entire experimental period, even in the period when vit. A was withdrawn from the ration (Table, 3). Similar results were observed when vit. A was administered in daily doses either orally or intramuscularly to the growing chicks (Table, 4).

Feeding growing chicks vit. A-supplemented ration for a 20-day peroid followed by a 10-day period of feeding vit. A freebalanced ration (Trt. 3) was associated with a significant reduction in plasma cholesterol levels of these animals compared to control (Table, 5). Resumption of feeding with vit A-rich diet was also associated with similar reduction in cholesterol levels (Table, 5). Daily oral or i.m. doses of vit A to chicks fed standard ration failed to show abnormal pattern in plasma cholesterol levels compared to control (Table, 5).

Regardless of the dose or route of administration of vit. A to growing chicks, the plasma levels of bilirubin (total and direct) as well as enzymes acivities of transaminases (SGOT and SGPT) and alkaline phosphatase were maintained within normal values throughout the entire experimental period (data not shown).

DISCUSSION

The present study demonstrates that exposing growing chicks to high levels of vit A, either orally or mixed with ration, did not adversely affect body Wt. This finding agrees with those of Pudelkiewicz et al. (1964), McCuaig and Motzok (1970), Hollonder (1981), and Cho (1982). However, daily i.m. injections of crudely estimated comparable doses of vit. A were associated with significant decreases in body weights of growing chicks. The reduction in body weight might be attributed to the stress of daily i.m. injection imposed on chicks. Also the fact that it may indicate a sign of toxicity can not be ruled out although no other classical symptoms of hypervitaminosis A were

observed in these animals. It is important to mention that the concentration of vit A in the ration was not measured in the present study, a fact that makes the exact amount of vit A given to growing chicks is more than that mentioned in this work.

The normal pattern of plasma B-carotene level in control birds showed a marked decline in the first 4 Wks of life. The reason behind this fact is not clear at present. One possibility is that it may suggest a lack of absorption by young chicks at this age hence B-carotene derived from egg-yolk might be the main source of chick's plasma B-carotene. The increase in plasma B-carotene level in young chicks by the 5th Wk of life and later on might suggest an improvement of absorption of this substance.

The present study indicates that the administration of high levels of vit. A was associated with an elevation of plasma level of the vitamin. Such elevation was more pronounced when vit. A was added to the either orally or intramuscularly. Although it may be suggested that a daily oral dose of the vitamin may escape efficient absorption, it is not clear why the i.m. injection of vitamin failed to raise the plasma vit. level above that observed in chicks fed vit. A-Supplemented ration.

It is also clearly evident that giving high levels of vit. A to growing chicks resulted in a marked reduction in plasma B-carotene levels in treated chicks. Dua et al. (1966) reported similar finding in response to increasing vit. A level in ration. Our results suggest that the high level of the vitamin in the digestive system and/or the plasma might interfere with the absorption of B-carotene. However, the fact that the daily i.m injection of the vit. did completely abolish the level of plasma B-carotene yet did not markedly increase the plasma level of the vitamin suggests that the role of plasma vit. A level is unlikely to be involved in this regard.

Withdrawing vitamin A from ration did normalize plasma level of the vit. but the liver content of the vit. remained high, indicating that the liver may have a role in controlling plasma level of vit. A by increasing its storage. The fact that plasma B-carotene level remained significantly lower than control inspite of the normalization of plasma vit. A level suggests that the liver may also play a role in controlling B-carotene level by exerting a feedback inhibition on B-carotene absorption. In this regard, it should be mentioned that measurement of liver content of B-carotene in response to increasing levels of vit. A was not attempted in the present study. Therefore, the possibility that the liver might play a role in controlling the storage of B-carotene can not be ruled out.

The long-term effect of administering high levels of vit. A to growing chicks in lowering plasma cholesterol levels was observed in those receiving the vit. mixed with the ration. It is difficult to explain the lack of similar effect of either orally or intramuscularly administered vit. A in lowering cholesterol content in chicks. March and Biely (1963) reported that a reduction in cholesterol absorption was related to high dietary level of vitamin A. Our study suggests that the delayed effect of high vitamin A intake on plasma content of cholesterol may include effects other than a simple interferance with cholesterol absorption. Ram and Misra (1979) pointed to a reduction in absorption of fatty materials due to decreased biosynthesis of phosphatidyl choline when high level of vitamin A was given.

SUMMARY

The administration of various high levels of vitamin A over different time course periods showed no classical signs to toxicity in growing broiler chicks.

A study on Hypervitaminosis-A in Broiler Chicken.

Feeding different levels of vitamin A (200,000 and 400,000 IU/kg diet) was associated with an elevation of plasma level of the vitamin. However, single doses of the vitamin (8,000 and 16,000 IU/bird/day) orally or intramuscularly were less effective in raising the plasma level of the vitamin. Liver content of vitamin A was higher than control through out the entire experimental period, even in the period where the vitamin was withdrawn from the ration. Regardless of the dose and route of administration of vitamin A, plasma B-carotene levels were markedly reduced in response to giving high levels of the vitamin. The pattern of plasma B-carotene level in control healthy chicks showed a marked reduction at the age of 26 days followed by a progressive rise afterward. Feeding vitamin A-supplemented diet to growing chicks for a prolonged period was associated with reductions in plasma cholesterol levels compared with control.

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