

THE EFFECT OF DIETARY MAGNESIUM LEVEL ON THE MAGNESIUM METABOLIZABILITY IN LAYING TSAIYA DUCK AND LEGHORN HEN

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Summary

The study was undertaken to determine the effect of various levels of dietary magnesium on the metabolizability of magnesium in laying Tsaiya ducks and Leghorn hens.

Twenty-five Tsaiya ducks and 25 Leghorn hens were raised in individual cages. The basal diet was mainly consisted of corn starch and isolated soybean protein. At the beginning of the experiments, birds were fed the basal diet added with 500 mg/kg Mg (1070 mg/kg in total by analysis) for 10 days in order to make the birds adapt to the new diet. Then, they were randomly divided into five treatments with five birds for each treatment and fed the experimental diets containing 690, 1070, 1690, 2150 or 2380 mg/kg Mg for 21 days and during the last five days excreta were collected. The experiment was repeated three times each at the age of 25, 31 and 36 weeks. The metabolizability of magnesium in the diet was determined by the indicator method.

The metabolizabilities of magnesium for Tsaiya duck and Leghorn hen were 59.9% and 62.5%, respectively as the diet contained 690 mg/kg magnesium, and were significantly decreased ($p < 0.05$) to 39.7 and 30.7%, respectively, when the dietary magnesium content was increased to 2380 mg/kg. (Key Words: Magnesium Metabolizability, Laying Duck, Leghorn Hen)

Introduction

The magnesium requirement for the laying hens has been well established (Cox and Sell, 1967; Edwards and Nugara, 1968; Hajj and Sell, 1969). The National Research Council (1984) recommended that the magnesium requirement for laying chicken was 500 mg/kg. Numerous studies (Stillmak and Sunde, 1971; McWard, 1967) had indicated that a high level of magnesium supplementation in the diet induced catharsis in the laying fowl. Monsey and Robinson (1977) also reported that loose droppings were observed when birds had been given with the high magnesium diet.

Atteh and Leeson (1983) indicated that the increasing in the magnesium level resulted in a significant decrease in the percentage of magnesium retained. However, no paper has concerned about the magnesium retention in laying duck. This study was therefore conducted to investigate the effect of dietary magnesium levels on the

magnesium metabolizability in laying Tsaiya duck and Leghorn hen.

Materials and Methods

Brown Tsaiya ducks (*Anas Platyrhynchos* var. *domestica*) and single comb White Leghorn hens (Hyline) used in this study were purchased from the local commercial hatcheries. All birds were raised with practical diet from day-old till the time ready for use in this investigation. Thirty ducks and 30 hens used in the experiment were selected on the basis of egg production record. Before the experiment, birds were fed for ten days with the semipurified diet mainly consisted of corn starch and isolated soy protein supplemented with 500 mg/kg Mg (as group 2 of experimental diets) to allow the birds adapting to the diet. And then, 25 ducks and 25 hens which were adapted well to the semipurified diet were respectively, selected on the basis of egg production and they were randomly divided into 5 treatment groups with 5 birds for each treatment. Each group of birds were then accepted the experimental diets (table I) which had been respectively supplemented with 0, 500, 1000, 1500, or 2000 mg/kg (i.e. 690, 1070, 1690, 2150 or 2380 mg/kg

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Received September 19, 1990

Accepted January 13, 1992

TABLE 1. COMPOSITION OF EXPERIMENTAL DIETS

Ingredient	Diets (%)				
	1	2	3	4	5
Corn starch	58.2				
Isolated soy protein (CP 86%)	21.04				
Dicalcium phosphate	1.6				
Calcium carbonate	8.3				
K ₂ HPO ₄	0.7				
NaHCO ₃	0.59				
Iodized salt	0.30		As diet 1		
Vitamin premix ¹	0.30				
Mineral premix ²	0.20				
Choline chloride (50%)	0.26				
DL-Methionine	0.3				
Soybean oil	2.0				
Tryptophan	0.05				
Chromic oxide	0.5				
Cellulose	5.66	5.15	4.64	4.13	3.62
MgSO ₄ · 7H ₂ O	0	0.51	1.02	1.53	2.04
Total	100.00	100.00	100.00	100.00	100.00
Calculated value:					
Crude protein (%)	18.6				
ME (kcal/kg)	2820		As diet 1		
Calcium (%)	3.5				
Available phosphorus (%)	0.49				
Magnesium (mg/kg)	0	500	1000	1500	2000
Analyzed value:					
Dry matter (%)	90.2	89.8	89.8	89.6	89.5
Magnesium (mg/kg)	690	1070	1690	2150	2380

¹ Vitamin premix supplied the followings per kilogram of diet: Vitamin A, 11250 IU; vitamin D₃, 1200 ICU; vitamin E, 37.5 IU; vitamin K₃, 2 mg; thiamin, 2.6 mg; riboflavin, 8 mg; vitamin B₆, 3 mg; Ca-pantothenate, 15 mg; niacin, 60 mg; d-biotin, 0.2 mg; folic acid, 0.65 mg and vitamin B₁₂, 0.013 mg.

² Mineral premix provided the followings per kilogram of diet: Cu (CuSO₄ · 5H₂O, 25.45% Cu) 10 mg; Fe (FeSO₄ · 7H₂O, 20.09% Fe) 100 mg; Mn (MnSO₄ · H₂O, 32.49% Mn) 60 mg; Zn (ZnO, 80.35% Zn) 65 mg; and Se (NaSeO₃, 45.65% Se) 0.15 mg.

based on the analysis) of Mg for a period of 21 days. The feed and water (Mg concentration less than 3 mg/l) were supplied *ad libitum*. The daily lighting period was maintained for 15 hours from 05:30 to 20:30. Experiments were repeated three times, of which each was initiated at 25, 31, and 36 weeks of age. The amount of feed consumption was also recorded throughout the experimental period.

The magnesium metabolizability was determined with the indicator method and 0.5% chromic oxide was served as the indicator. Birds

were fed twice a day around 8:00 AM and 6:00 PM, respectively. Representative samples of excreta from individual birds were collected at 5:00 PM for 5 consecutive days. After being dried for 22 hrs 65°C in an oven, each dried excreta sample was separately ground by passing through a Willey mill with a 20-mesh screen. The magnesium metabolizability was calculated by the following equation:

$$\text{Mg metabolizability (\%)} = \frac{\text{excreta DM (\%)} \times \text{excreta Mg (mg/kg)}}{\text{feed DM (\%)} \times \text{feed Mg (mg/kg)}}$$

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$$\left(\frac{\text{feed Cr (\%)}}{\text{excreta Cr(\%)}} \right) \times 100$$

The amounts of feed consumption were recorded throughout the experimental period. The dry matter and Mg content of the feed and of excreta samples were determined according to procedures described in the Association of Official Analytical Chemists (AOAC, 1984). For determining the Cr content of the feed and of the excreta samples, a modified method after AOAC (1984) by Chen and Shen (1989) was used.

The obtained data were subjected to analysis of their variance, and where a significant difference existed, means were further subjected to

Duncan's new multiple range test (Steel and Torrie, 1980).

Results and Discussion

Feed consumption and magnesium intake

Magnesium supplementation did not affect the feed consumption of Tsaiya ducks as shown in table 2. The feed consumption of Leghorn hens in group 2 which had been fed with diet containing 1070 mg/kg Mg was significantly higher ($p < 0.05$) than that of group 1. However, there was no significant difference when comparisons were made to those of other groups. Obviously,

TABLE 2. EFFECT OF DIETARY MAGNESIUM CONTENT ON FEED CONSUMPTION AND MAGNESIUM INTAKE IN TSAIYA DUCKS AND LEGHORN HENS

Group	Dietary Mg (mg/kg)	Feed consumption ¹ (g/bird/day)		Magnesium intake ² (mg/bird/day)	
		Duck	Hen	Duck	Hen
1	690	178 ^a	104 ^a	123.4 ^d	71.3 ^e
2	1070	181 ^a	116 ^b	197.0 ^c	122.9 ^d
3	1690	186 ^a	108 ^{ab}	331.8 ^b	172.4 ^c
4	2150	189 ^a	110 ^{ab}	425.0 ^a	225.2 ^b
5	2380	195 ^a	109 ^{ab}	477.8 ^a	253.4 ^a
Pooled S.D.		10	4	32.0	7.8

^{a-e} Means on the same column without common superscripts differ significantly ($p < 0.05$).

¹ Feed consumption was expressed on as fed basis.

² Magnesium intake = feed consumption \times analyzed dietary Mg content.

the basal diet containing 690 mg/kg Mg was sufficient for both Tsaiya ducks and Leghorn hens.

The amount of Mg intake was obtained by multiplying the feed consumption with the dietary Mg content. The results (table 2) showed that the Mg intake was increased when the Mg level in the diet of Tsaiya ducks and Leghorn hens had been both increased.

Metabolizability and retention of magnesium

As data shown in table 3, the metabolizability of dietary Mg in both ducks and Leghorn hens were decreased when their dietary Mg content was increased. In Tsaiya ducks, as the dietary Mg level increased from 690 to 2380 mg/kg, the Mg metabolizability was decreased from 59.9% to 39.7%. In Leghorn hens, the result was very similar to that of Tsaiya ducks. These results agree with that of Atteh and Leeson (1983) who

found that an increase of the dietary magnesium resulted in a significant decrease in the percentage of magnesium retained in Leghorn hens. The addition of magnesium in the diet resulted in a decrease in magnesium metabolizability might be due to the cathartic effect induced by high levels of magnesium as indicated by Stillmak and Sundt (1971) and Lee and Britton (1987). Another possible explanation was that the high plasma magnesium concentration (data not shown) which arised from the supplementation of dietary magnesium would subsequently result in the increase of magnesium excretion in the urine and also reduced the metabolizability of magnesium. In the present study, the correlation between Mg metabolizability and plasma concentration was significantly negative ($r = -0.58$ in duck; $r = -0.66$ in hen, $p < 0.05$) and this fact could be a good evidence for supporting the previous explanation.

TABLE 3. EFFECT OF DIETARY MAGNESIUM CONTENT ON METABOLIZABILITY AND RETENTION OF MAGNESIUM IN TSAIYA DUCKS AND LEGHORN HENS

Group	Dietary Mg (mg/kg)	Mg metabolizability (%)		Mg retention (mg/bird/day) ¹	
		Duck	Hen	Duck	Hen
1	690	59.9 ^a	62.5 ^a	74.3 ^a	44.8 ^b
2	1070	56.9 ^a	52.9 ^{ab}	111.3 ^{ab}	64.6 ^a
3	1690	52.5 ^{ab}	35.6 ^{bc}	176.3 ^{bc}	61.6 ^a
4	2150	40.0 ^b	36.5 ^{bc}	168.9 ^{bc}	81.9 ^a
5	2380	39.7 ^b	30.8 ^c	190.1 ^c	78.6 ^a
Pooled S.D.		7.4	10.6	32.2	19.6

Means on the same column without common superscripts differ significantly ($p < 0.05$).

¹ Magnesium retention = feed consumption \times analyzed dietary magnesium content \times % Magnesium metabolizability.

The amounts of magnesium retained in the Tsaiya ducks was different from that in the Leghorn hens (table 3). The magnesium retention in Tsaiya ducks of group 5 was 2 times more than that in Tsaiya ducks of group 1, indicating that high level of magnesium in the diet for this kind of birds would result in a significant elevation of their magnesium retention ($p < 0.05$). However, the same effect in Leghorn hens was not significant ($p > 0.05$) although their magnesium retention was also increased from 44.8 to 81.9 mg/bird/day due to the supplementation of 1500 mg/kg magnesium in the basal diet. The difference occurred in Mg retention between ducks and hens may be due to: (1) the Mg intake of ducks was almost twice of those of hens; (2) the Mg metabolizability was slightly higher in ducks fed higher Mg diets.

These results indicate that the increase of dietary magnesium would reduce the utilization of dietary magnesium in both Tsaiya ducks and Leghorn hens. While the metabolizability of dietary magnesium was decreased when the level of dietary magnesium had been increased, the total magnesium retention was increased in response to the higher amount of magnesium supplemented in the diet.

Acknowledgements

We wish to thank Mr. S. W. Lin and Ms. Y. C. Li for their assistance, and Ms. W. L. Chen for her suggestions. We also wish to express our sincere appreciation to the National Science Council of the Republic of China for the financial

support.

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