Study on performance enhancing effect of Rare Earth Elements as alternatives to antibiotic feed additives for Japanese Quails

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Abstract: The presents study was designed to determine the effect of different levels of rare earth elements (REE) on growth performance of Japanese quails. A total of 300 one day old j. quails were nearly of the same live body weight and divided into equal four triplicate groups, each replicate contained 25 birds.Control group fed on basal diet (isonitrogenous and isocaloric) and the three quail groups were fed the same diet, which supplemented with 50,100 and 200 mg /kg of REE-citrate, lanthanide mixture. The quail chicks were reared in plastic reticular boxes for four weeks and during it feed and water was ad-libitum.The results showed there were a significant differences in the final body weight and body gain between quail groups. The REE supplements increased the weight gain of Japanese quails compare to control group by 18.5-22% during the experiment. The feed consumption and the feed conversion improvement were not significantly affected by REE. REE-citrate improved the feed conversion ratio by 8.06-10.22%. The lowest concentration of REE-citrate (50 mg/kg) improved the efficiency of protein and energy utilization by 12.61% and 10.89% compare to control group Based on the results of present study, the optimum concentration range of REE- citrate for improving both growth performances and efficiency of protein and energy utilization was 50-100 mg/kg of feed.
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1. Introduction

The remaining antibiotic feed additives used in food- producing animals were banned from use for some years in many countries in the world. So there is a need for developing an alternative which promotes growth and also enhances the feed efficiency. Probiotics, prebiotics, organic acids and enzymes are already known as replacement for antibiotic feed additives but rare earth elements (REE) might be the new generation of growth promoters **(Wenk, 2003).**

Rare earth elements (REE) are 15 lanthanide elements with atomic numbers 57 (lanthanum) through 71 (lutetium), which are in group III A of the periodic table. Despite their name, the REE are used for 40 years as performance enhancers in agricultural plant production and remarkable results were reported from Chinese agricultural operations **(wan et al., 1998).** In animal production, as with plants, amazing results have been achieved by supplying REE in animal diet, in Chinese literature. It was reported that proper concentrations of REE in diet can improve animal growth performance without effecting quality of products **(Wang and Xu, 2003).**

Supplementation of rare earth elements had positive effect on both animal growth and feed conversion of pigs and poultry kept and fed under western conditions **(Rambeck et al., 1999, 2005 and He et al., 2001, 2006a and 2006b)**. However some studies showed no positive effect of REE or showed negative effect of high concentrations of REE on growth performance **(Schuller, 2002 and Kraatz et al., 2004).**

The present study was conducted to investigate the effect of dietary rare earth elements on growth performance and feed efficiency of Japanese quails.

2. Materials and Methods

Experimental birds: A total number of 300 Japanese quails one day old were used in this study. The quails were from the breed produced in institute of animal physiology and nutrition of Munich University. The birds were randomly distributed into equal four groups, each contained 75 birds, each group was subdivided into another three subgroups, and each one contained 25 birds. The average initial body weights of different groups were nearly similar (7.41gm ± 0.08).

Composition of experimental diets:-The one day Japanese quails were fed with control diet and three treatment diets until four weeks old. The control diet was the basal diet with no additives and the treatment diets were basal diet plus rare earth elements. Rare earth elements were used as feed additive to study their effect on growth performance. The basal diet

was formulated according to **NRC nutrient requirements of poultry (1994)**. The basal diet was prepared in a mash form and sample of diet was taken for chemical analysis according to **A.O.A.C (1980)** and the composition of the diet is shown in table (1).

Table (1): Composition of basal diet

Ingredients	Percent (%)
Corn meal	36.05
Soy bean meal	55.0
Cal. Carbonate	1.80
Soy oil	5.00
Mono cal. Phosphate	1.20
Dl. Methionin	0.30
Vitamin mix.	0.25
Trace mineral mix.	0.10
NaCl	0.30
Total	**100**
Analyzed nutrient composition	
Dry matter (%)	90
Crude protein (%)	23.9
ME (Mj/kg)	12.13
Crude fiber (%)	2.5
Calcium (%)	0.82
Available phosphor, (AP %)	0.33

Rare earth elements- citrate was used as rare earth elements with different concentrations in treatment diets. REE – citrate was a lanthanide mixture containing 5.5% La, 17.5% Ce and 3.28% Pr. This REE- citrate was used with three concentrations (50, 100, 200 ppm) in three treatment diets (table, 2). The REE with mineral and vitamin supplements were added and mixed with diet at the end of making ration. Quails of different groups kept on iso nitrogenous 23.9% crude protein and iso energetic 12.13 ME (Mj/kg diet).

Table (2): Diets of the experiment

Diet	Statement
1	Control (basal diet)
2	Basal diet + 50mg/kg REE - citrate
3	Basal diet + 100 mg/kg REE - citrate
4	Basal diet + 200 mg/kg REE - citrate

Rearing condition: The one day old quail chicks were accommodated in experimental house and reared in cages (plastic reticular boxes with the size of 60x08cm) and provided with clean feeders and waters. All quails were kept under the same hygienic and environmental conditions, twenty –four hour continuous lighting and the temperature was 38°C at the first day and was decreased by 2°C every two days during the first week, then decreased by 4°C to reach 22°C by the end of fourth week.

Measured Parameters:- Total and individual body weight and feed intake were recorded for each of different groups at 0, 7, 14, 21, 28 days of age to calculate weight gain (gm), feed conversion rate and efficiency of protein utilization (gm gain/ gm crude protein consumed) and efficiency of energy utilization (ME consumed Mj/gm gain).

Statistical analysis:

Statistical analysis of the data was performed to determine the significance of difference in all parameters according to **Snedcor and Cochran (1982).**

3. Results and discussion

The results of average body weight , body gain, feed consumption feed conversion rate, efficiency of protein and energy utilization of quails in different groups after one week are shown in table (3). There was significant difference between experimental groups. The highest average body weight and feed utilization (efficiency) were record in group (3), which fed on diet contained 100 mg REE /kg (23.31 g , 417.52) , followed by group 4 (22.37 g , 407.66) .

The best efficiency of protein and energy utilization (1.75 and 29.05) was observed in gp. (3).

REE supplement increased body weight for 17.12% to 22.04% in compare to control group. These results confirms the results of **(Zhang and Shao, 1995) and Yang et al. 2005**, who reported that growth promoting effect of rare earth elements increases weight gain of 8-23 % and decreased feed conversion 8-16 % in chickens. The results of growth parameters in different groups after two weeks are summarized in table (4). The average body weight and feed conversion rate of quails in different groups showed significant difference. Groups fed REE supplement recorded the highest body weight, body gain and the best fed conversion rate than control group. The REE supplement increased body weight for 13.29% to 15.21% in compare to control group.

There was positive effect of REE on improving feed conversion rate, protein efficiency ratio and energy utilization. **Halle et al. (2003b and 2004)** reported that 100mg /kg REE supplement had positive effect on growth performance of broiler chicks.

The results in table (5) shows that quails were fed REE had highest body weight and feed efficiency than control group. The protein efficiency ratio and performance index were higher in group (3) fed diet contained 100 mg/kg REE (1.45 and 2.87%).

Also as shown in table (6) the REE supplement groups recorded the best body weight, feed conversion ratio and performance index, from these results, REE had positive effect on growth performance of J. quails although this effect was not significant. Also comparison the levels of REE supplement showed that J. quails fed 100 mg/kg gained more weight than the quails fed 50 mg/kg or 200 mg/kg. **He et al., (2006a)** showed low concentration of REE (40-70 mg/kg) improved weight gain and feed conversion ratio of broiles chicks.

Also, **Zohravi (2006)** concluded that the optimum concentration range of REE –citrate for improving both growth parameters and tibia mineralization was 50-100mg/kg feed.

Results concerning body gain, feed conversion rate, protein efficiency ratio, performance index, efficiency of energy utilization and survivability of j. quail groups all over the experimental period are present in table (7). The results in this table revealed that group fed diet supplemented with REE had significant difference in body weight and the best feed conversion rate than control group.

The REE supplements increased body weight and gain of J. quails compare to control group by 8.82-10.25% and 8.07-9.64% respectively.

REE–citrate decreased the feed conversion rate by 8.06-10.22% compare to control .The feed consumption and the feed conversion improvement were not significantly affected by REE-Supplement.

Also the REE improved the protein efficiency ratio and efficiency of energy utilization by 9.91-12.61% and 9.17-11.23% respectively.

Feeding experiments performed under western conditions showed increased body weight up to 7 % and improved feed conversion ratio up to 3% in chickens **(Halle et al., 2002, 2004)**. While studies by **He et al., (2006a)** showed increased body weight gain 5-13% in broiler chicks.

The survival rate of J. quails was higher after the first week of experiment .The percentage of survival rate during the whole period of experiment was 93-97%. As there was no special disease detected during the experiment. From this study, it could be concluded that REE-citrate supplement to J. quails diet had positive effect on body gain and feed efficiency mainly in groups fed diets contained 50-100 mg REE/kg diet.

Table: (3) Effect of dietary REE on growth performance of J. quails after one week.

Parameters	Groups			
	1	2	3	4
Body weight at one day old (g)	7.33 ± 0.10[a]	7.41 ± 0.07[a]	7.44 ± 0.09[a]	7.47 ±0.05[a]
Body weight after one week (g)	19.10 ± 0.29[c]	22.42 ± 0.15[b]	23.31 ± 0.15[a]	22.37 ± 0.37[b]
Body weight gain (g)	11.79 ± 0.28c	15.02 ±0.12b	15.87 ± 0.17a	14.90 ± 0.35b
Feed consumption (g)	35.01 ± 0.92[a]	37.15 ± 0.88[a]	38.01 ± 1.22[a]	36.55 ± 1.41[a]
Feed conversion rate	2.99 ± 0.02[b]	2.47 ± 0.08[a]	2.39 ± 0.09[a]	2.45 ± 0.12[a]
Protein consumption (g)	8.37	8.88	9.08	8.74
Protein efficiency ratio	1.41	1.69	1.75	1.71
Feed efficiency	336.18	404.30	417.52	407.66
Performance index (%)	0.63	0.90	0.97	0.91
Efficiency of energy utilization	36.08	30.00	29.05	29.76

Table: (4) Effect of dietary REE on growth performance of J. quails after two weeks.

Parameters	Groups			
	1	2	3	4
Body weight after one week (g)	19.10 ± 0.29[c]	22.42 ± 0.15[b]	23.31 ± 0.15[a]	22.37 ± 0.37[b]
Body weight after two week (g)	44.78 ± 0.82[b]	51.30 ± 0.29[a]	51.59 ± 0.33[a]	50.73 ± 0.35[a]
Body weight gain (g)	26.07 ± 0.55[b]	28.88 ± 0.15[a]	28.28 ± 0.19[a]	28.36 ± 0.06[a]
Feed consumption (g)	73.69 ± 1.13[a]	76.23 ± 1.68[a]	74.52 ± 0.62[a]	74.48 ± 0.91[a]
Feed conversion rate	2.86 ± 0.05[a]	2.64 ± 0.06[b]	2.63 ± 0.01[b]	2.62 ± 0.03[b]
Protein consumption (g)	17.61	18.22	17.81	17.80
Protein efficiency ratio	1.48	1.59	1.59	1.59
Feed efficiency	353.77	378.85	379.49	380.77
Performance index (%)	1.56	1.94	1.96	1.93
Efficiency of energy utilization	34.28	32.02	31.96	31.86

Table: (5) Effect of dietary REE on growth performance of J. quails after three weeks.

Parameters	Groups			
	1	2	3	4
Body weight after two weeks (g)	44.78 ± 0.82[b]	51.30 ± 0.29[a]	51.59 ± 0.33[a]	50.73 ± 0.35[a]
Body weight after three week (g)	74.32 ± 1.04[b]	81.84 ± 0.64[a]	82.70 ± 0.69[a]	81.88 ± 0.62[a]
Body weight gain (g)	29.68 ± 0.83[a]	30.54 ± 0.39[a]	31.12 ± 0.49[a]	31.15 ± 0.28[a]
Feed consumption (g)	92.88 ± 2.22[a]	89.11 ± 1.86[a]	89.78 ± 0.69[a]	89.68 ± 2.04[a]
Feed conversion rate	3.17 ± 0.13[a]	2.89 ± 0.06[a]	2.88 ± 0.03[a]	2.88 ± 0.08[a]
Protein consumption (g)	22.20	21.30	21.46	21.43
Protein efficiency ratio	1.33	1.43	1.45	1.45
Feed efficiency	318.42	342.72	346.62	347.34
Performance index (%)	2.34	2.83	2.87	2.84
Efficiency of energy utilization	38.08	35.39	34.99	34.92

Table: (6) Effect of dietary REE on growth performance of J. quails after four week.

Parameters	Groups			
	1	2	3	4
Body weight after three week (g)	74.32 ± 1.04[b]	81.84 ± 0.64[a]	82.70 ± 0.69[a]	81.88 ± 0.62[a]
Body weight after four week (g)	93.59 ± 0.60[c]	102.28 ± 0.21[ab]	103.18 ± 0.58[a]	101.84 ± 1.09[ab]
Body weight gain (g)	19.30 ± 1.55[a]	20.44 ± 0.69[a]	20.48 ± 1.03[a]	19.96 ± 0.92[a]
Feed consumption (g)	127.44 ± 3.84[a]	115.97 ± 4.90[a]	112.25 ± 3.36[a]	114.89 ± 5.35[a]
Feed conversion rate	6.66 ± 0.48[b]	5.69 ± 0.37[a]	5.49 ± 0.23[a]	5.75 ± 0.52[a]
Protein consumption (g)	30.46	27.72	26.83	27.46
Protein efficiency ratio	0.63	0.74	0.76	0.73
Feed efficiency	151.44	176.25	182.44	173.73
Performance index (%)	1.41	1.79	1.87	1.77
Efficiency of energy utilization	80.09	68.82	66.48	69.82

Table: (7) Effect of dietary REE on growth performance of J. quails after 1-28 days.

Parameters	Groups			
	1	2	3	4
Body weight at one day old (g)	7.33 ± 0.10[a]	7.41 ± 0.07[a]	7.44 ± 0.09[a]	7.47 ±0.05[a]
Body weight after four week (g)	93.59 ±0.60[c]	102.28 ± 0.21[ab]	103.18 ± 0.58[a]	101.84 ± 1.09[ab]
Body weight gain (g)	87.32 ± 0.65[b]	94.87 ± 0.14[a]	95.74 ± 0.67[a]	94.37 ± 1.05[a]
Feed consumption (g)	329.02 ± 2.71[a]	318.45 ± 8.02[a]	327.67 ± 15.06[a]	315.60 ± 6.38[a]
Feed conversion rate	3.72 ± 0.02[a]	3.35 ± 0.08[a]	3.42 ± 0.18[a]	3.34 ± 0.10[a]
Protein consumption (g)	78.64	76.11	78.31	75.43
Protein efficiency ratio	1.11	1.25	1.22	1.25
Feed efficiency	265.39	297.91	292.18	299.01
Performance index (%)	2.51	3.05	3.02	3.05
Efficiency of energy utilization	45.70	40.72	41.51	40.57
Survival rate (%)	93	96	97	97

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