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Effects of chelated iron and zinc supplementation on egg quality of laying hens

Sharmin K.N.[1], Taleb, M. A.[2], Morshed, M.S.[1], Kamaruddin, K.M.[3] and M. F. Bin Quader[1]

[1]Assistant Professor, Faculty of Food science and Technology, Chittagong Veterinary and Animal Sciences University, Chittagong-4225, Bangladesh; [2]Product Manager, Renata Animal Health Division, Dhaka, Bangladesh; [3]Ex-Director, Poultry Research and Training Centre, Chittagong Veterinary and Animal Sciences University , Chittagong-4225, Bangladesh

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** Corresponding Author :*
Email: shaimin@gmail.com
Cell : +88 01199019294

A B S T R A C T

The experiment was designed to evaluate the effect of supplemented iron (Fe) and zinc (Zn) on egg quality. A total of two thousand commercial layer chickens aged at 70 weeks were selected from a layer farm of Patia sadar upazilla (sub-district) of Chittagong district. One thousand layers were assigned randomly to each treatment and control group. Treatment group fed with controlled diets with supplemented trace mineral named 'Poultry TMO' that contains Mintrex Zinc 32 ppm and Glytrex Fe 5 ppm, at the dose of one gm/kg feed. After nine weeks, twelve freshly laid eggs were collected randomly from each group. Atomic absorption spectrophotometer (AAS) and analytical graded reagent were used for analyzing the iron and zinc content of these eggs. The mean value of iron (mg/100gm of egg yolk) of the eggs of dietary treatment group was higher than the control group (2.01 vs. 1.442, $p < 0.001$). The mean value of zinc (mg/100gm of egg yolk) of treatment group was also higher ($P < 0.05$) than the control (0.458 vs.0.391. The mean weight of egg yolk was not significantly different between two groups (14.66 gm vs. 14.61g. The finding indicates that supplementation of zinc and iron in laying chicken could be helpful to increase the zinc and iron level in eggs.

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1. INTRODUCTION

Iron is an integral part of many proteins and enzymes that maintain sound health. In humans, iron is an essential component of proteins involved in oxygen transport (Dallman, 1986). It is also necessary for the regulation of cell growth and differentiation (Bothwell et al., 1979; Andrews, 1999). A deficiency of iron limits oxygen delivery to cells, resulting in fatigue, poor work performance and decreased immunity (Haas and Brownlie, 2001) and (Bhaskaram, 2001). Beside this anaemia is one of the prevalent public health problems in Bangladesh. It poses a major threat to maternal and child survival, contributes to low birth weight, lowered resistance to infection, poor cognitive development and decreased work productivity. It has profound effect on health, both physical and mental, thereby affecting quality of life, and translating into major economic losses for the individuals and for the country. These impacts are estimated to cost Bangladesh 7.9% of its gross domestic product BBS (2004). The magnitude of anemia and its adverse consequences on health and economic need intensified action to address this public health problem. According to the Bangladesh's first ever combined micronutrients survey, the under-five and school-aged children are suffering less from anaemia while almost half of all pre-school aged children and more than half of women are suffering from zinc deficiency HKI/IPHN(2002).

The bioavailability of plant-based foods is generally lower due to dietary fiber and phytic acid which inhibit the absorption of zinc and iron. Chicken egg is the dietary source of iron and zinc to meet the requirement of recommended dietary allowance partially. Recommended Dietary Allowance (RDA) of zinc for infant, adolescent, pregnant women and lactating mother are 5mg, 10 mg, 12 mg and 13 mg respectively and RDA of iron for infant, adolescent, pregnant women and lactating mother are 7 mg, 11 mg, 27 mg and 18 mg respectively which was set by the Food and Nutrition Board (2001).

Despite supplementation of iron and folic acid tablets over the past few decades, no marked improvement has been noticed in the magnitude of anemia in Bangladesh. So it will be beneficial for us to increase the quantity of iron, zinc in food. It may help us to reduce micronutrient deficiency. This study was conducted to know whether iron, zinc supplementation in commercial layer can increase the amount of iron and zinc in egg which could be helpful to reduce the micronutrient deficiencies.

2. MATERIALS AND METHODS

The study was conducted for a period from March, 2014 to October 2014 in Haitgaon Taslim Layer Farm of Patia Sadar upazila in Chittagong district and at Quality Control and Analytical Labrotary of Chittagong Vetrerinary and Animal Sciences University, Chittagong. A total of two thousand commercial layer birds were selected from 70 weeks of age.

2.1. Experimental Design and Treatments

It was a completely randomized experimental study design. A total two thousand hens (ISA BROWN) at 70 weeks old were randomly selected from the farm flock at the similar in weight and productivity. Then the laying hens were randomly assigned to the treatment and control group having one thousand layers. Birds were housed in a layer house with two double and overlapping metal cages. Each case had two internal compartments, with a capacity of four birds each, therefore allowing 8 birds per cage. The cages were equipped with water lain and metal trough feeders placed along the front of the cages. A lighting program of 16 hours of light daily was adopted.

2.2. Feeding and management

Feed was offered ad libitum feed in the morning and in the afternoon. They (both group) fed with the control layer diets (as shown in Table 1) which consisted primarily of corn and soybean meal. The control layer diets covered all the essential nutrients recommended by the NRC in the early 1990s NRC (1994).The analytical values of the control layer diets were tabulated in Table 1.

The Dietary treatment were as follows : Control diet (Table 1) was formulated to meet nutritional requirement which were added to the experimental diets separately (Table 2).Control diet was supplemented with organic chelated trace mineral named Poultry TMO provided by Novus Int. and delivered mixing with control diet to laying hens up-to 9 weeks. The Dietary treatments group received control diets with supplemented Mintrex ZN 32 ppm, Mintrex Cu 8 ppm, Mintrex Mn 32 ppm , Glytrex Fe 5 ppm, Zorien SeY 0.15 ppm, KI 1.2 ppm, Methionine Value 393 gm/kg at the dose of 1 gm per 1 kg of feed. Chelation consists of two molecules of ligand and one atom of trace mineral with 4-coordinate covalent bonds which provide superior stability over a wide range of pH and higher ability to deliver higher levels of trace minerals in to the blood.

Table 1. Composition and calculated analysis of the control diet

Ingredients	%
Corn	58
Rice polish	9.5
Soyebean meal	16.47
Protein concentrate	5.5
Calcium carbonate ($CaCO_3$)	9
Di calcium phosphate	0.4
Vitamin mineral premix	0.2
Lysine	0.04
Methinine	0.1
Nacl	0.4
Salmonella Killer	0.15
Toxin binder	0.05
Enzyme(NSP)	0.04
Phytase	0.1
Total	100
ME (kcal/kg)	2800
CP (%)	16.6
Ca (%)	4.16
Av. P (%)	0.35
Lysine	0.8
Methionine (%) 0.34	0.4
Methionin + Cystine (%) 0.62	0.68
Na (%)	0.18

*Supplied per kg of diet: Vit. A, 15000 IU; Vit. D3, 2000 IU; Vit. E, 20 mg; Vit K3, 1 mg; Vit. B1, 1.2 mg; Vit. B2 3.5 mg; B12 0.006 mg; Pantothenic acid 3 mg; Biotein 0.21 mg; Choline 250 mg; Copper 6mg; Iron 60 mg; Manganse 60 mg; Zinc 40 mg; Selenium 0.066 mg;

Table 2. Experimental Diet

Ingredients	ppm
Mintrex ZN	32
Mintrex Cu	8
Mintrex Mn	32
Glytrex Fe	5
Zorien SeY	0.15
KI	1.2
Methionine Value	393 g/Kg

2.3. Collection of Egg Sample

After 9 weeks, the freshly laid eggs of commercial laying hens were collected from both groups. Twelve numbers of eggs were taken from each group. Each time of collection, all the eggs were collected randomly with individual serial number.

2.4. Chemical analysis

Atomic absorption spectrophotometer (AAS) and Analytical graded reagent were used for analysis the iron and zinc content of this selected eggs. Sample digestion, standard preparation and sample analysis had done according to described methods in the British pharmacopoeia, (2005).

2.5. Statistical analysis

Data were processed and analyzed statistically using computer software SPSS version18 (Statistical Package for Social Sciences). Independent sample t-test was conducted to compare mean concentration of Fe, Zn and weight of yolk. For comparison the means of different parameter 5% significance level was considered.

3. RESULTS AND DISCUSSION

Table 3 show that the mean value of Iron and Zinc (mg/100gm of egg yolk) content between dietary treatment and control group. The mean value of Iron (mg/100gm of egg yolk) of dietary treatment group was higher than the control group which was highly statistical significant (P <0.001). Correspondingly the mean value of Zinc (mg/100gm of egg yolk) of dietary treatment group was significantly higher than the control group. This difference was may be observed due to the effect of organic Iron and Zinc supplementation in dietary treatment group.

Table 3. Iron and Zinc content in eggs between the groups (n=12 in each group)

Group	Control	Treatment	*P* value
Mean value of Iron ±SD (mg/100gm of egg yolk)	1.442 ±0.204	2.01 ±0.384	0.001
Mean value of Zinc ± SD (mg/100gm of egg yolk)	0.391 ±0.075	0.458 ±0.074	0.03

Result was expressed in 95% CI.

This study was to some extent consistent with other study in which it was stated that there are two interactions among divalent minerals such as Fe, Zn and Cu (Paik et al., 2009). This may be scientifically logic since the combination of 120 mg Fe/kg diet with 80 mg of Zinc/kg and 25 mg of Cu/kg increased Fe concentration in the yolk and white by 36.7 and 34.9% respectively (Skrivan et al., 2005). In addition (Yang et *al*., 2004) indicated that Fe contents were increased in egg yolk of hens fed diets supplemented with Fe, Zn, I and Se. In these respect Mabe et al. (2003) found an increase in Zn, Mn and Cu concentration in egg yolk when they supplemented the laying hen diets with the same minerals. It was worthy to note that, in laying hens, there are two specific proteins transmissive of iron (F II) in their blood plasma. They are transferrin and phosvitin. At onset of eggs, phosvitin increases in blood plasma. It may be attributed to the estrogen hormone change in blood, which stimulate phosvitin constituting in bird's liver, also promote iron metabolism, so phosvitin increase till the peak of egg production reaching the outmost level, where the binding capacity of ferous (Fe II) with phosvitin was maximize producing ferous-phosvitin compound which directly go to egg yolk and deposit in it (El-Hossiny and Abo-El alla, 1990). On the contrary supplemented Cu or Zn individually to hen's diets without iron supplementation reduced the concentration of iron in egg than the control diet. Skrivan et al. (2005) found that, the concentration of iron in egg yolk was reduced when hen's diets supplemented with Cu 25mg or Zn 80mg/kg diet individually as compared with those fed the control diet. Notable, supplemented Cu or Zn individually in combination with iron in each of them at the levels of 100 or 200 mg Fe/kg diet, raised iron concentration in egg by 18.60 and 52.56% for Cu at the two mentioned levels of iron respectively while the increment were 28.37 and 60.00% for Zn with the previously two levels of iron respectively when compared to the control diet. Adding 100 or 200 mg Fe/kg diet without Cu or Zn increased the concentration of iron in egg by 7.44 and 11.63%, respectively as compared to the control diet. In this respect, Skrivan et al. (2005) reported that, when layers diets supplemented with 120 mg iron/kg diet, the concentration of iron increased by 6.3% and 2.2% in egg Yolk and White respectively. Moreover Bertchini et al. (2000) and Youjin et al. (2004) showed that the content of egg Yolk iron (mg/100 g) increased significantly when iron supplementation increased in diet at the level of 80 ppm.

Kidd et al. (1992) did a study in which progeny from broiler breeders fed 72 mg Zn/kg diet had heavier embryonic bones and improved immune status, as a result of Zn accumulation in the egg. Similar results were found by Flinchum et al. (1989). Eggs represent a good opportunity for supplying extra zinc to human diets. Zinc content of egg yolk is closely related to diet content (Nabe and Squires, 1991), adding 80 mg/kg of zinc to a laying hen diet containing 65 mg/kg (NRC states for 50 mg lkg addition of Zn to laying hen diets) increased egg yolk zinc levels from 0.84 to1.62 mg/egg.

Table 4 shows that the mean value of weight of egg yolk in gram between dietary treatment and control group. The mean value of egg yolk weight between two groups was not statistically significant.

Table 4. Weight of egg yolk between the groups (n=12 in each group)

Group	Mean Weight of Egg yolk ± SD (gm)	*P* value
Control	14.61± 0.17	0.376
Treatment	14.66± 0.20	

The result of this present study was consistent with other studies (Ramadan N A. et al. 2010).

4. CONCLUSION

Dietary treatment to the laying hen supplemented with organic trace minerals gave the best concentration to eggs. This study assist to identified and explore factors that related to Iron and Zinc to reduce the micronutrient deficiency at national, community and individual level.

Recommendation

The treated chicken egg may provide the framework and foundation for healthful diet during all the stage of human and also provide the best concentration of iron and zinc that reduce the micronutrient deficiency of human. Awareness program regarding nutritional modification among Bangladeshi population should be properly addressed by policy makers. Further experimental studies needed to identify the effect of organic Iron and Zinc supplementation in laying hens to reduce the micronutrient deficiency of human.

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