



Production of zinc enriched designer eggs through dietary supplementation



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Abstract

Designer eggs have high market demand because of the consumers' willingness to purchase them owing to its' nutritional qualities additional to regular eggs. The current study was conducted to produce zinc enriched eggs by supplementing laying hens' diet with required levels of zinc as inorganic zinc sulphate (75mg/kg). Thirty-two number of crossbred (White Leghorn N strain and Desi) layer birds were given zinc enriched diet from 29 weeks of age for 12 weeks. The concentration of zinc in egg of birds supplemented with zinc diet was significantly higher ($p < 0.01$) than that of unsupplemented group. The egg zinc concentration of supplemented birds was elevated from 33.36 ± 0.89 ppm (control group) to 40.85 ± 0.47 ppm (supplemented group)

Keywords: Designer eggs, Zinc sulphate

Zinc is an essential trace micronutrient mineral which is an integral part of over 300 enzymes involved in carbohydrate, nucleic acid and protein metabolism. Zinc has a systemic role in fertility, antioxidation, skeletal and neurobehavioural functions. In addition, zinc plays a key role in the immune system, transport and the use of vitamin A. Many plant foods have high zinc content particularly cereal grains and legumes, but bioavailability is less due to presence of phytates. Though the richest zinc sources are animal products such as beef, pork and shellfish, they are expensive. Therefore, zinc deficiency is widely felt in human population. The zinc content of hen's eggs can be upgraded by relatively simple and economical dietary approaches and can be marketed at reasonable price.

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Materials and Methods

Experimental layout

The study was conducted using thirty-two numbers of 28 weeks old crossbred (White Leghorn N strain X Desi) layer birds procured from All India Coordinated Research Projects (AICRP) on Poultry for Eggs, Mannuthy, KVASU. The birds were distributed in a completely randomized experimental design and they were placed into two treatment groups, each with four replicates having four birds in each replicate. All birds were fed with a standard layer diet and raised under standard managemental conditions up to 28 weeks of age at AICRP on Poultry for Eggs Mannuthy, KVASU. The birds were immunized against diseases as per standard protocol followed in the farm. On completion of 28 weeks of age, the birds were brought and housed in well ventilated cages of animal house attached to Department of Veterinary Physiology. They were kept at $24.5 \pm 0.5^{\circ}\text{C}$ ambient temperature and at relative humidity ranging from 60-80 per cent. A photoperiod of 16 h per day was ensured throughout the period.

Feeding of birds with zinc enriched diet

Zinc level in control diet was formulated according to BIS 2007 standards. Treatment group was provided with a diet incorporating inorganic zinc sulphate @ 75 mg/kg mash diet. The total ration was provided as a single lot in the morning. Water was provided *ad libitum* throughout the experimental period of 84 days.

Estimation of zinc content of egg

One egg was randomly selected from each treatment group at weekly interval and the contents of raw egg were subjected for microwave acid digestion to estimate Zn content. Three mL of pooled whole egg sample

was subjected for digestion using 6.0 mL of HNO_3 and 1.0 mL of H_2O_2 in teflon digestion vessel. The mixture was carefully stirred with a clean glass rod for 10 min before closing the vessel. Microwave digestion was set with the following program (Table 1).

The digested samples were analysed for Zn by Atomic Absorption Spectrometry standard method, (AOAC., 2016). The PinAAcle 900H Series AAS enabled a simple automated measurement of Zn using hollow cathode lamp of wavelength 213.86 nm and lamp current of 15 mA. Calibration curve was plotted with standards ranging from 0 to 6 ppm with a calibration equation non-linear through zero. Slit width of 0.7nm ensured accurate analysis. The flame atomizer with a temperature of 2400°C , was ideal for the measurement. Fuel and oxidant gases were acetylene (2.5 L/min) and air (10 L/min) respectively.

Statistical analysis

Results were expressed as means ($\pm\text{SE}$). The statistical significance of difference or relation between the two treatments were analysed by CRD using the software Statistical Product and Services (SPSS) version 24.0 and the differences were considered statistically significant at 5% level ($p < 0.05$) (Snedecor and Cochran, 1994).

Results and Discussion

Zinc content in egg sample

Consumers are always driving the market for a new category of food with health benefits beyond the traditionally value. Zinc enriched eggs in the market have a potential demand because of its systemic role in immunocompetence, skeletal and neurobehavioural development.

Table 1: Microwave digestion programme

Step	Target temperature ($^{\circ}\text{C}$)	Pressure (max) (bar)	Ramp time (min)	Hold time (min)	Power (%)
1	165	30	5	10	50
2	190	30	5	20	80
3	50	30	1	10	0

Table 2: Mean value of zinc concentration (mg/L (ppm)) in eggs of different treatment groups

Treatment group	No of samples	Mean value of amount (ppm)	p-value	F value
		Mean±S.E.		
T1	12	33.36 ^a ±0.89	0.000**	31.798
T2	12	40.85 ^b ±0.47		

Means bearing same superscript within a column do not differ significantly ($p < 0.05$)

** Highly significant ($p < 0.01$)

Samples subjected for microwave digestion were analyzed for zinc by AAS and zinc concentration in egg yolk, when hens were supplemented with inorganic zinc sulphate at a level of 75 mg / kg mash diet are presented in the table 2

The effect of zinc feeding was highly significant ($p < 0.01$) for zinc concentration range in eggs. It was noticed that hens fed the diet enriched with inorganic zinc sulphate exhibited higher zinc level in eggs compared to other group under conventional feed. Supplemented zinc resulted in significant difference in zinc content of eggs. It was clearly noticed that egg zinc content increased significantly ($p < 0.01$) by increasing the zinc level to 75 mg/Kg diet.

In the present study, the mean zinc content in diet supplemented group (T2) was significantly ($p < 0.01$) greater than basal diet fed group (T1) as represented in table 2. These findings were completely agreed with the data of Kim and Patterson (2005) who confirmed that, linear increase in zinc supplementation through diet could result more pronounced incorporation of zinc in eggs. The present study findings are also supported by Stahl *et al.* (1988) who found an increase of 57-95 % zinc in eggs while feeding hens with elevated levels of zinc at the rate of 1861 mg/kg diet. This linear increment in zinc content of eggs through dietary supplementation could be attributed to the production of a trace mineral transporting protein called vitellogenin. Vitellogenin transport zinc from liver storage to ovaries (Richards, 1997).

Cousins (1985) reported that excess supplementation of zinc through diet would make the absorptive membrane more leaky,

which allowed zinc to enter the cell and bind non-specifically to cell proteins and other ligands. Hence an optimum level of dietary supplementation (75mg/kg) was selected for the present study, which had yielded Zn enriched eggs. As per BIS 2007, the recommended zinc requirement of layer birds (21-45 weeks) was 60 mg/kg.

Reports of Williams *et al.* (1989), Plaimast *et al.* (2008), Bahakaim *et al.* (2014) and Aghaei *et al.* (2017) indicated a strong positive correlation between dietary as well as yolk content of zinc. The zinc content of enriched eggs obtained in the current study, 40.85±0.47 ppm (T2) was comparable with the results Kaya *et al.* (2001) who reported a zinc level of 27.62 to 36.69 µg/g egg.

On contrary, when 80 mg Zn was introduced to the hens' basal diet, Skrivan *et al.* (2005) found no major variations in egg yolk, white and shell zinc content and they attributed the antagonistic effects of Zn and Cu as one of the reasons for non enrichment of eggs.

Conclusion

The dietary supplementation of hens with zinc is an effective approach to supply consumers with foods from animal sources that are enriched with zinc. Current findings showed that feeding of zinc supplemented diet to chickens offered a promising measure to enrich egg with zinc.

Ethical approval and consent statement

The experiment was approved by the Institutional Animal Ethics Committee (IAEC) of College of Veterinary and Animal Sciences, Mannuthy.

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