EFFECT OF SUPPLEMENTATION OF CHROMIUM NANOPARTICLES ON EGG WEIGHT AND EGG QUALITY CHARACTERISTICS IN LAYERS

V. Malathi, Jayanaik and N.K.S. Gowda

Department of Poultry Science,
Veterinary College, KVAFSU, Bangalore, 560 024, India

Corresponding Author : drmalathiprasadreddy@rediffmail.com

ABSTRACT

A study was conducted to investigate the effect of supplementation of different levels of Chromium nanoparticles (NanoCr) in layers. 360 brown layers of 28 weeks age were randomly allocated to five treatment groups (supplemented with 0, 50, 100, 200 and 400 ppb NanoCr). At 32, 36 and 40 weeks age, eggs were collected to assess the egg weight, yolk, albumen, shell per cent and shell thickness, Haugh unit and egg indices. Egg weight linearly increased at all ages with NanoCr. Albumen per cent significantly increased and yolk and shell per cent significantly decreased ($p \leq 0.05$) whereas albumen index and haugh unit score at 36 and 40 weeks age significantly increased in NanoCr supplemented groups. These results indicated that NanoCr supplementation to layers improved egg weight and albumen quality.

KEY WORDS : Chromium, Nanoparticles, Egg weight, Egg quality, Layers

INTRODUCTION

Chromium (Cr) is a well-known essential trace element for humans and animals. Although there are no specifications for chromium in poultry diets (NRC, 1997), several studies provide evidence for improved performance with supplementation of chromium (Sahin *et al*., 2002a). Also, studies have reported that Cr supplementation resulted in higher egg production, egg weight, egg mass and albumen quality (Uyanýk *et al*., 2002).

The development of nanotechnology has brought new applications to many fields. Some reports have indicated that nanoparticle drugs and minerals could be absorbed more efficiently than their conventional forms (Desai *et al*., 1997). Lien *et al*. (2009) reported that the nanoparticle CrPic significantly increased the CrPic digestibility, as well as increased serum chromium level in rats. Studies on Nano chromium in layers to evaluate its effect on egg production and egg quality parameters at different ages are very scanty. The objective of this study was to investigate the effects of supplementing chromium nanoparticles to layers on egg weight and egg quality at different ages.

MATERIALS AND METHODS

Experimental design and diets

A total of three hundred and sixty brown layers (Rhode Island Red) of 28 weeks age were randomly allocated to five treatment groups with four replicates in each group (eighteen birds in each replicate). The five treatments used were (1) control group fed with basal diet formulated as per NRC (1994) (2) basal diet supplemented with 50 ppb NanoCr, (3) basal diet supplemented with 100 ppb NanoCr, (4) basal diet supplemented with 200 ppb NanoCr, (5) basal diet supplemented with 400 ppb NanoCr. The experiment was carried out till 40 weeks of age and the birds were maintained on deep litter system with all standard managemental conditions. Birds were given 145 g feed per day and received 15 hours light. The research protocol was approved by the Institutional Animal ethics Committee (IAEC) of the University. NanoCr (powder form) required for the trial was obtained from Ritus Nutraceuticals, Chennai (India) and the average particle size of Cr was 80 nm. The Cr concentration in the sample was estimated by Inductively Coupled Plasma – Optical Emission Spectrophotometer (ICP-OES; Perkin Elmer Optima 8000) using argon gas as fuel and nitrogen gas for purging at 267.716 nm wave length.

Egg weight and egg quality parameters

At 32, 36 and 40 weeks age, four eggs from each replicate (16 eggs from each treatment) were collected to measure egg weight, shell weight and egg quality. Shell thickness was measured at five points of the egg using digital Screw gauze. Albumen index, yolk index and shape index (as per cent) were determined as described by Romanoff and Romanoff (1949). Haugh unit (HU) was calculated according to the equation: Haugh unit (HU) = 100 x log (H - 1.7×$W^{0.37}$ + 7.57), where, H is the albumen height (mm) and W is the egg weight (g) (Nesheim *et al*., 1979). The shell weight, yolk weight and albumen weight were measured individually and expressed as per cent of egg weight. All the egg parameters were measured on the same day of collection.

The experiment was conducted using completely randomized design. The data were subjected to ANOVA using SPSS software version 20.0 . The linear and quadratic effects of NanoCr concentration were assessed using orthogonal polynomials. Means were compared by Duncan's multiple-range test and a *P*-value of less than 0.05 was considered statistically significant (Duncan, 1995).

RESULTS AND DISCUSSION

Egg weight

The effects of varying levels of NanoCr on egg weight, yolk, albumen and shell per cent at different ages are presented in Table 1. The egg weight increased significantly ($p \leq 0.05$) with increasing levels of NanoCr at 32 weeks, 36 weeks and 40 weeks of age. Also, the response of increase in egg weight at all the three ages was linear. Sirirat *et al*. (2013) reported significant increase in egg weight in layers supplemented with nanoparticles of Cr picolinate at 500 ppb level, but egg weight was reduced at 3000 ppb level. Several studies have reported similar effect using other forms of Cr. Cr picolonate supplementation to layers at low ambient temperature significantly increased egg weight (Sahin *et al*., 2002b). On the contrary, no effect of supplemental Cr on egg weight was reported by many workers (Uyanik *et al*., 2002; Lien *et al*., 2004; Huseyin *et al*., 2010).

Egg quality parameters

At 32 weeks of age, yolk, albumen and shell per cent did not differ in NanoCr supplemented group when compared to the control group. At 36 weeks and 40 weeks, yolk and shell per cent decreased significantly with NanoCr supplementation, whereas, albumen % significantly increased in NanoCr supplemented groups. Albumen per cent was highest in 400 ppb NanoCr group. In all these three parameters, the response was linear ($p \leq 0.05$). These results are in conformity with those observed by Sirirat *et al*. (2013) and Abdallah *et al.* (2013) using higher level of NanoCr. The findings in this study strongly suggest that Cr is involved in maintenance of the normal physical state of egg albumen.

The effects of NanoCr on various egg indices, shell thickness and Haugh unit are presented in Table 2. Shape index and shell thickness at different ages in the present study was not affected by the supplementation of NanoCr. Similarly Huseyin *et al.* (2010) reported that Cr yeast supplementation to layers (150 ppb) did not affect shape index and shell thickness. Sirirat *et al.* (2013) also indicated that the shell thickness was not affected by 500 and 3000 ppb nanoparticles of Cr picolinate. However, some studies suggest positive effect of Cr on shell thickness (Sahin *et al*., 2002b). At 32 weeks age, albumen index and Haugh unit were not influenced by NanoCr supplementation, but yolk index reduced significantly and linearly ($p \leq 0.05$) with increasing levels of NanoCr in the diet. At 36 and 40 weeks age, both the albumen index and Haugh unit significantly increased with the influence of NanoCr and the response was linear ($p \leq 0.05$) with increment in the levels of inclusion of the same. Yolk index was not affected by NanoCr supplementation at 36 and 40 weeks age. Similar to these results, Sirirat *et al*. (2013) reported positive effect of

Table 1. Effect of supplementation of different levels of Chromium Nanoparticles on egg weight, yolk percent, albumen percent and shell percent in layers at different age intervals.

Age	Items	NanoCr levels (ppb)						P-value	
		0	50	100	200	400	SEM	Linear	Quadratic
32 weeks	Egg wt (g)	54.56^{b}	56.51^{b}	57.58^{b}	57.50^{b}	62.14^{a}	0.60	0.000	0.296
	Yolk %	29.39	31.16	31.64	30.59	29.47	0.37	0.875	0.022
	Albumen %	60.43	58.57	58.13	59.63	60.47	0.40	0.682	0.031
	Shell %	10.17	10.26	10.23	9.77	10.05	0.13	0.453	0.957
36 weeks	Egg wt (g)	52.76^{d}	55.27^{c}	57.24^{b}	58.00^{b}	60.49^{a}	0.504	0.00	0.621
	Yolk %	35.50^{a}	34.59^{a}	33.54^{a}	31.14^{b}	30.32^{b}	0.47	0.00	0.707
	Albumen %	53.31^{c}	55.17b^{c}	56.98^{ab}	59.72^{a}	59.48^{a}	0.553	0.00	0.343
	Shell %	11.19^{a}	10.23^{b}	9.48b^{c}	9.13^{c}	10.19^{b}	0.159	0.001	0.00
40 weeks	Egg wt (g)	55.56^{c}	56.51^{c}	59.04^{b}	59.67^{b}	61.42^{a}	0.425	0.00	0.896
	Yolk %	33.43^{a}	33.03^{ab}	31.53^{abc}	31.01b^{c}	30.26^{c}	0.350	0.001	0.910
	Albumen %	55.31^{c}	56.79^{bc}	58.94^{ab}	58.89^{ab}	59.79^{a}	0.437	0.00	0.285
	Shell %	11.24^{a}	10.17^{b}	9.52^{b}	10.10^{b}	9.94^{b}	0.157	0.008	0.010

$^{a,\ b,\ c,d}$ Means within a row carrying different superscripts differ significantly ($p \leq 0.05$).

Table 2 Effect of supplementation of different levels of Chromium Nanoparticles on egg quality parameters in layers at different age intervals.

Age	Items	NanoCr levels (ppb)						P-value	
		0	50	100	200	400	SEM	Linear	Quadratic
32 weeks	Shape Index	76.64	75.41	75.99	75.14	77.76	0.522	0.601	0. 165
	Albumen Index	6.28	6.19	6.76	6.62	6.80	0.124	0.105	0.867
	Yolk Index	41.50^{a}	39.85^{ab}	38.18^{b}	38.02^{b}	38.45^{b}	0.405	0.004	0.072
	Shell thickness (mm)	0.362	0.377	0.374	0.367	0.371	0.004	0.802	0.482
	Haugh Unit	76.25	75.75	75.65	75.38	76.19	0.445	0.881	0.537
36 weeks	Shape Index	77.26	76.95	76.43	77.37	75.58	0.525	0.450	0.746
	Albumen Index	5.68^{d}	6.16^{cd}	6.69^{bc}	7.32^{ab}	7.83^{a}	0.174	0.000	0.880
	Yolk Index	39.48	38.14	37.90	38.01	38.36	0.375	0.387	0.253
	Shell thickness (mm)	0.355	0.357	0.354	0.346	0.356	0.002	0. .627	0.597
	Haugh Unit	76.37^{cd}	76.06^{d}	77.20^{bc}	77.47^{b}	79.07^{a}	0.228	0.000	0.036
40 weeks	Shape Index	76.38	75.48	75.22	75.25	75.96	0.430	0.736	0.352
	Albumen Index	5.93^{d}	6.35^{cd}	7.14^{bc}	7.41^{ab}	8.25^{a}	0.185	0.000	0.787
	Yolk Index	34.63^{ab}	36.77^{a}	36.49^{a}	33.63^{b}	37.28^{a}	0.428	0.434	0.889
	Shell thickness (mm)	0.384	0.404	0.371	0.390	0.387	0.007	0.908	0.922
	Haugh Unit	77.09^{c}	78.09^{bc}	78.44^{bc}	79.09^{ab}	80.12^{a}	0.264	0.001	0.849

a, b, c Means within a row carrying different superscripts differ significantly (p?0.05).

nanoparticles of Cr picolinate supplementation on albumen index, yolk index and Haugh unit. Abdallah *et al*. (2013) observed significant improvement in yolk index and did not show beneficial effect on albumen index by supplementing layers with Cr picolinate. Improvement in Haugh unit score was also reported upon Cr picolinate and Cr yeast (Sahin *et al.,* 2002b) supplementation. The positive effect of NanoCr on albumen index further substantiates the definite role of Cr in maintaining egg albumen quality. Further, since Haugh unit score is a measure of albumen quality, significant increase in Haugh unit score is a clear indication of the role of Cr in improving albumen quality.

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