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Egg Quality, Fertility and Hatchability of Laying Quails Fed Diets Supplemented with Organic Zinc, Chromium Yeast or Mannan Oligosaccharides

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Abstract: The aim of this study was to investigate the effect of supplementing diets of laying Japanese quails (n = 250; 8 wk of age) with bioplex zinc, chromium yeast or Mannan Oligosaccharides (MOS) on egg weight, egg quality, fertility, hatchability and hatching chick weight. Diets were a basal diet or the basal diet supplemented with 20 mg bioplex zinc (Zn1), 40 mg bioplex zinc (Zn2), 600 mg Cr yeast (Cr1), 1200 mg Cr yeast (Cr2), 1.0 g MOS, Zn1 plus MOS, Zn2 plus MOS, Cr1 plus MOS or Cr2 plus MOS. Egg weight tended to be higher (p = 0.188) with the tested supplements compared to the control. Egg quality was not affected by the studied supplements. The high zinc diet or Cr2+MOS diet tended to improve egg fertility, while Zn1, Zn1+MOS or Zn2+MOS diets improved egg hatchability (p<0.001). The high Cr diet and Cr2+MOS diet tended to increase hatching chick weight. It is concluded that, supplementation of laying Japanese quail diets with bioplex zinc, chromium yeast or mannan oligosaccharides tended to increase egg weight without affecting egg quality. Supplementing the diets with 40 mg bioplex zinc or 1200 mg chromium yeast + 1.0 g mannan oligosaccharides/kg tended to improve egg fertility and hatching chick weight. Supplementing the diets with bioplex zinc up to 40 mg/kg alone or in combinations with 1.0 g mannan oligosaccharides/kg improved egg hatchability significantly.

Key words: Quail, chromium, zinc, mannan oligosaccharides, egg quality, fertility, hatchability

INTRODUCTION

The fertility could highly vary even within the same breed mainly due to poor management, improper proportion of males or poor ability of males in the flock to produce viable sperms (Malago and Baitilwake, 2009). Breeder factors that affect hatchability include health, nutrition, egg size, weight and quality (King'ori, 2011).

Zinc can manipulate the reproductive system of the bird (Park *et al*., 2004). Zinc has multiple important functions because it is a cofactor of more than 200 enzymes (Prasad and Kucuk, 2002). Dietary Zn supplementation improved the hatchability of laying hen (Anshan, 1990).

Chromium is essential for activating certain enzymes and for stabilization of proteins and nucleic acids (Anderson, 1994). Sahin *et al*. (2001) observed that chromium picolinate supplementation of Japanese quail diets increased albumen index and albumen weight. Contreras *et al*. (2000) found that supplementation of Japanese quail diets with chromium methionine improved the fertility of eggs.

Prebiotics had beneficial effects on microbial environment in the gut, which might enhance digestion, absorption and utilization of nutrients (Gibson *et al*., 2005). Mannan oligosaccharides are a group of prebiotics that work by providing alternate binding sites for pathogenic bacteria. These are typically derived from yeast (*Saccharomyces cerevisiae*) outer cell wall components (Lomax and Calder, 2009). Shashidhara and Devegowda (2003) found that 0.5 g mannan oligosaccharides increased fertility and hatchability of broiler breeders.

The objective of this study was to investigate the effects of supplementing diets of laying Japanese quails with bioplex zinc, chromium yeast or mannan oligosaccharides on egg weight, egg quality, fertility, hatchability and hatching chick weight.

MATERIALS AND METHODS

Japanese quails (*Coturnix coturnix japonica*) (n = 250; 8 wk of age) were randomly and equally divided into ten groups each of 25 birds (20 females and 5 males). Quails groups were assigned randomly to ten experimental diets, being a basal laying diet (control, diet 1; Table 1) and the basal diet supplemented with 20 mg bioplex zinc, a chelated zinc proteinate (3.0 mg zinc)/kg (diet 2), 40 mg bioplex zinc (6.0 mg zinc)/kg (diet 3), 600 mg Cr yeast (0.6 mg Cr)/kg (diet 4), 1200 mg Cr yeast (1.2 mg Cr)/kg (diet 5), 1.0 g Bio-MOS, a Mannan Oligosaccharides (MOS)/kg (diet 6), 20 mg bioplex zinc plus 1.0 g MOS (diet 7), 40 mg bioplex zinc plus 1.0 g MOS (diet 8), 600 mg Cr yeast plus 1.0 g MOS (diet 9) or 1200 mg Cr yeast plus 1.0 g MOS (diet 10).

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Table 1: Composition and calculated analyses of the basal diets

Ingredients, %	
Yellow corn	55.60
Soybean meal (48%)	25.20
Corn gluten meal (62%)	4.30
Wheat bran	5.50
Di-Ca-P	1.50
Limestone	7.00
Premix*	0.30
NaCl	0.25
L-lysine-HCL	0.10
DL-methionine	0.15
Mold guard	0.10
Calculated analyses**	
Crude protein, %	20.35
Ether extract, %	2.75
Calcium, %	3.07
Available P%	0.38
Lysine, %	1.06
Methionine, %	0.49
Methionine + cystine, %	0.81
ME kcal/kg	2960.00

*Each 1 kg contained: Vit A 4000000 IU, Vit D 833333 IU, Vit E 3.33 g, vit K 0.67 g, vit B_1 0.33 g, vit B_2 1.67 g, vit B_6 0.50 g, vit B_{12} 0.003 g, Niacin 10 g, Folic 0.33 g, Biotin 0.017 g, Pantothenic acid 3.33 g, Copper 3.33 g, Iodine 0.33 g, Selenium 0.03 g, Iron 10 g, Manganese 20 g, Zinc 16.67 g, Cobalt 0.033 g.
**Calculated using NRC (1994)

The basal laying diet was formulated to cover the recommended nutritional requirements of laying Japanese quail (NRC, 1994). Quails were fed the experimental diets for 6 weeks (8 wk to 14wk of age). Diets and fresh water were provided *ad libitum*. Birds were reared at natural house temperature during the experiment (from 21 August to 2 October). Quails were exposed to 16 L: 8 D lighting program. All groups received the same hygienic and managerial conditions. Hundred eggs (10 eggs/treatment) were collected at the week 12 of age (4th week of the experiment) to determine egg quality. Shape index according to Romanoff and Romanoff (1949), haugh units (measured as the logarithm of albumen height according to the equation mentioned by Card and Nesheim (1976), yolk index shell percentage, albumen percentage and yolk percentage were determined.

During week 14 of age (6th week of the experiment), all the laid eggs (340 eggs) during two successive days (34 eggs/treatment) were collected, weighed and incubated in a forced draught laboratory incubator at 37.5°C. After hatching, newborn chicks were weighed and then the percentage of fertility (as percentage of incubated eggs) and hatchability (as a percentage of fertile eggs) were calculated.

The analysis of variance for completely randomized design experiments using general linear models procedure of SAS (1994) examined the effects of dietary treatments. The model used was:

$$Y_{ij} = \mu + T_i + £_{ij}$$

Where: Y_{ij} = Observation, μ = Population mean, T_i = Diet effect, $£_{ijk}$ = Random error.

Differences among treatment means were detected using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Egg weight of supplemented quails tended to be higher ($p = 0.188$) than the control (Table 2). Shape index, shell %, albumin %, haugh units and Yolk % were not affected by the studied supplements (Table 2). Yolk index was not affected by dietary supplementation with Cr2, MOS, Cr1 + MOS, Zn1 + MOS or Zn2 + MOS but it was lowered ($p = 0.001$) by Zn1, Zn2, Cr1 or Cr2 + MOS supplementation compared to the control (Table 2). The present results are in accordance with Park *et al.* (2004) who found that egg weights from hens fed Zn propionate were heavier than those from hens fed on feed with no supplemental Zn and Chen *et al.* (2005) reported that prebiotics increased egg weight of laying hen. Sahin *et al.* (2002) found that increasing dietary Cr did not affect eggshell thickness of laying Japanese quail. Chen *et al.* (2005) reported that prebiotics did not affect albumen quality of laying hen. Moreover, Saldanha (2008) found no differences in egg quality of laying hens fed diets supplemented with different levels of Zn. Zinc supplementation of quail diets did not influence eggshell thickness and weight, haugh unit, yolk index, or albumen index (Cruz and Fernandez, 2011).

The high zinc diet (Zn2) or Cr2+MOS diet tended to improve egg fertility. Fertility % of eggs of quails fed Zn1, Cr2 supplemented diets was similar to the control (Table 3). Fertility % was lowered significantly with Cr1, MOS, Cr1 + MOS, Zn1 + MOS or Zn2 + MOS supplementation, being the lowest with Cr1 + MOS supplemented diet. The fertility could highly vary even within the same breed mainly due to poor management, improper proportion of males or poor ability of males in the flock to produce viable sperms Malago and Baitilwake (2009). Cheng (2007) found that addition of 0.4, 0.6, 0.8 or 1.0 mg yeast chrome/kg of the diet of breeder cocks increased the sperm quantity, sperm activity and sperm density to certain extent and decreased the sperm deformity rate. Moreover, Contreras *et al.* (2000) found that supplementation of Japanese quail diets with chromium methionine improved egg fertility. Also, zinc has multiple important functions because it is a cofactor for more than 200 enzymes (Prasad and Kucuk, 2002). Zinc has been demonstrated to play a vital role in the reproduction of the chicken (Wedekind *et al.*, 1990). In addition, Shashidhara and Devegowda (2003) found that 0.5g mannan oligosaccharides increased fertility of broiler breeders.

Hatchability % was superior ($p<0.001$) with Zn1, Zn1 + MOS and Zn2 + MOS supplemented diets compared to the control. Hatchability % of egg of quails fed Cr1, Cr2,

Table 2: Egg quality of laying quails fed diets supplemented with organic Zinc (Zn), Chromium yeast (Cr) or mannan oligosaccharides (MOS)

Traits	Control	Zn1	Zn2	Cr1	Cr2	MOS	Zn1 + MOS	Zn2 + MOS	Cr1 + MOS	Cr2 + MOS	SEM*	p-value
Egg weight, g	12.52	13.17	12.30	13.50	13.25	13.57	13.31	13.32	13.28	13.68	1.17	0.188
Shape index	78.42	78.54	78.52	78.24	77.57	79.48	78.44	77.17	78.01	78.27	0.39	0.903
Shell, %	8.68	7.92	7.67	7.94	7.76	8.21	7.95	7.97	8.27	7.82	0.52	0.224
Albumen, %	58.92	61.37	59.72	59.89	60.82	60.47	60.07	61.35	59.91	59.98	0.83	0.224
Haugh units	92.05	91.25	92.62	92.96	90.67	94.19	92.03	96.03	94.04	91.17	5.46	0.525
Yolk, %	32.18	30.71	32.44	32.17	31.43	31.28	31.87	30.68	31.79	32.20	0.40	0.763
Yolk index	52.50[a]	45.60[c]	46.60[bc]	45.50[c]	50.20[ab]	50.30[ab]	49.10[abc]	51.30[a]	52.50[a]	46.50[bc]	0.35	0.001

*SEM = Standard Error of the Means

Table 3: Fertility %, hatchability % and hatching chick weight of eggs laid by quails fed diets supplemented with organic zinc (Zn), chromium yeast (Cr) or mannan oligosaccharides (MOS)

Traits	Control	Zn1	Zn2	Cr1	Cr2	MOS	Zn1 + MOS	Zn2 + MOS	Cr1 + MOS	Cr2 + MOS	SEM*	p-value
Fertility, %	96.00[a]	93.75[a]	96.97[a]	85.29[bc]	93.94[a]	83.33[cd]	85.19[bc]	88.46[b]	81.82[d]	96.88[a]	1.41	<0.001
Hatchability, %	91.67[b]	96.67[a]	87.50[c]	89.66[bc]	90.32[bc]	92.00[b]	95.65[a]	95.65[a]	72.22[d]	90.32[bc]	1.41	<0.001
HCW, g	9.35[ab]	8.33[c]	8.64[bc]	9.30[ab]	9.54[a]	9.25[ab]	9.24[ab]	8.77[abc]	8.23[c]	9.45[ab]	0.35	0.028

*SEM = Standard Error of the Means. HCW = Hatching Chick Weight, g

MOS or Cr2 + MOS supplemented diets was similar to the control (Table 3). Hatchability % of eggs laid by quails fed Zn2 or Cr1 + MOS supplemented diets was significantly lower compared to the control, being noticeably the lowest with Cr1 + MOS diet (Table 3). Weight of the hatched quails was the highest with Cr2 or Cr2 + MOS dietary supplementation. Hatching weights of Zn1 or Cr1 + MOS groups were lower (p = 0.028) than the control (Table 3). Egg size typically affects hatching mass in birds because the main effect of egg size lies in the mass of the residual yolk sac that the chick retains at hatching (Williams, 1994). Senapati *et al.* (1996) reported positive correlation between egg weight and hatchability, which is in accordance with the present results of Zn1, Zn1+ MOS or Zn2 + MOS supplemented groups. King'ori (2011) reported that among the most influential egg parameters that influence hatchability are weight, shell thickness and shape index. Hatchability for small eggs is lower than medium and large eggs, which is in accordance with the present results of Cr1 + MOS supplemented group that recorded depressed egg hatchability along with the lowest chick hatching weight. Abiola (1999); Abiola *et al.* (2008) and Malago and Baitilwake (2009) showed that there was close correlation between egg size and chick hatching weight. Breeder factors that affect hatchability include health, nutrition, egg size, weight and quality (King'ori, 2011). Moreover, prebiotics had beneficial effects on microbial environment in the gut, which might enhance digestion, absorption and utilization of nutrients (Gibson *et al.*, 2005). Mannan oligosaccharides improved intestinal absorption of some nutrients, such as Zn (Shashidhara and Devegowda, 2003). In accordance with the present results, dietary Zn supplementation improved the hatchability of laying hen (Anshan, 1990). Shashidhara and Devegowda (2003) found that 0.5 g mannan oligosaccharides increased fertility and hatchability of broiler breeders.

It is concluded that, supplementation of laying Japanese quail diets with bioplex zinc, chromium yeast or mannan oligosaccharides tended to increase egg weight without affecting egg quality. Supplementing the diets with 40mg bioplex zinc or 1200 mg chromium yeast + 1.0 g mannan oligosaccharides/kg tended to improve egg fertility and hatching chick weight. Supplementing the diets with bioplex zinc up to 40 mg/kg alone or in combinations with 1.0 g mannan oligosaccharides/kg improved egg hatchability significantly.

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