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EFFECTS OF SELENIUM AND CHROMIUM SUPPLEMENTATION IN THE DIET OF QUAILS ON LIVE PERFORMANCE AND SOME BLOOD PARAMETERS

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Abstract

The objective of this work was to investigate the effects of supplemental selenium (Se) and chromium (Cr) on live performance and some blood parameters in quails. A total of 90 10-day-old quails (Coturnix coturnix japonica) were used, and the work was terminated after 30 days. The birds were randomly assigned to caging units, 30 birds each. Water and the diets were consumed by the birds ad libitum throughout the experiment. The quails were fed either 1- a basal diet, 2- the basal diet supplemented with either 0.2 ppm Se(SeO_2) or 3- the basal diet supplemented with 0.2 ppm Se plus 500 ppm Cr ($Na_2Cr_2O_7.2H_2O$).Supplemental Se and Se+Cr resulted in a decrease in live weight gains ($P \geq 0.0238$). Supplemental Se decreased the live weight gain but a combination of Se+Cr caused alleviation on this decrease. Feed consumption increased in quails fed a diet supplemented with Se; however, supplementing Se and Cr together decreased the feed consumption but still greater than that of control ($P < 0.0001$). Feed conversion ratio did not change among treatments ($P = 0.3220$). Selenium supplementation alone did not change the serum concentrations of glucose or total protein whereas Se+Cr treatment resulted in an increase in glucose ($P = 0.0036$) but a decrease in total protein concentrations ($P = 0.0189$). Serum cholesterol or triglycerides concentrations remained similar among treatments ($P = 0.2026$). Serum AST enzyme activity decreased with Se supplementation but more with Se+Cr treatments ($P = 0.0587$). Supplementing Se and Se+Cr to the diet of quails resulted in a decrease in serum concentrations of Ca ($P = 0.0009$), P ($P = 0.0720$) and Na ($P < 0.0001$) but no changes in Mg or Cl concentrations ($P \geq 0.2442$). Supplementing Se and Se+Cr to the diet of quails resulted in an increase in serum concentrations of Fe, Cu, Al and Mn. Selenium treatment caused an increase in serum concentration of Zn but Se+Cr treatment resulted in a decrease in Zn concentrations ($P = 0.0027$). As expected, supplementing quail diets with both Se and Cr resulted in increases in serum concentrations of Se and Cr($P < 0.0001$). In conclusion, Se alone or as a combination with Cr supplementation to the diet of quails resulted in a depressed live performance thus are not recommended in the diet.

***Key words**: quails, chromium, selenium, performance.*

INTRODUCTION

Trace elements are important in growth performance of animals including poultry. Providing enough trace elements growth is crucial. NRC (1994) has already recommended the dietary concentrations of trace elements for quails. However, supplementing excess amounts and combination of trace elements to the diet of quails are still unknown.
Selenium (Se) as an essential element acts as a highly effective antioxidant with its function (presence) in the active site of the selenoenzyme (glutathione peroxidase, GSH-Px). This enzyme, together with superoxide dismutase and catalase, protects cells against damage caused by free radicals and lipoperoxides (Combs and Combs, 1986).The positive effects of Se supplementation on quail growth have been known, particularly during heat stress (Sahin and Kucuk, 2007).
Chromium (Cr) as an essential element potentiates the action of insulin through its presence in an organometallic molecule called glucose tolerance factor (Anderson, 1987). Dietary chromium supplementation has been reported to have a positive effect on the growth rate, feed efficiency of growing poultry (Cupo and Donaldson, 1987; Lien et al., 1999) as well as on decreasing mortality and altering the

glucose metabolism of chickens (Lien et al., 1999). These beneficial effects of chromium are increased by dietary, physical and hormonal stress (Anderson, 1994; Wright et al., 1994). Supplemental dietary chromium is also recommended by NRC (1994) for animals undergoing environmental stress.

The objective of this study was to evaluate the effects of Se alone or in a combination with Cr supplementation on live performance and some blood parameters of Japanese quails under an intensive production system.

MATERIALS AND METHODS

A total of 90 10-day-old Japanese quails (*Coturnix coturnix japonica*) obtained from Erciyes University Quail Facility, Kayseri, Turkey was used in the study. The birds with equal numbers of males and females were randomly assigned, according to their initial body weights, to three treatment groups, three replicates of 10 birds each. The birds were kept in cages (four birds per subcage of 19 cm x 19 cm x 19 cm).

The birds received either a control diet or control diet supplemented with 0.2 ppm Se (selenium dioxide - SeO_2) or control diet supplemented with both 0.2 ppm Se and 500 ppm Cr (sodium dichromate dehydrate ($Na_2Cr_2O_7.2H_2O$). The study took 30 days. The birds were fed a commercial diet containing 21.5 % HP and 3000 Mcal/kg ME. Ingredients and chemical compositions of the diet are shown in Table 1. The diets were formulated using NRC (1994) guidelines. Small amounts of the basal diet were first mixed with the respective amounts of elements as a small batch, then with a larger amount of the basal diet until the total amount of the respective diets was homogeneously mixed. The diets and fresh water were offered ad libitum. Light was provided all the time (24 h) inside the hen house.

The experiment was conducted between 15 May and 15 June. At weekly intervals, feed intake and body weight were determined on group basis as replicates of each treatment. Weight gain and feed efficiency of groups were then calculated. At the end of the experiment, all birds from each group were slaughtered and blood (5 cc) was collected. Blood samples were centrifuged at 3 000 × *g* for 10 min and serum was collected from Vena brachialis and stored at –20°C for later analysis. Serum samples were thawed at room temperature. On thawed samples Se, Cr, Ca, P, Mg, Fe, Cu, Zn, Na, K, Al, Mn concentrations were measured using ICP/MS (Agilent 7500a series, Berghof Speedwave, Germany). Serum concentrations of total protein, glucose, cholesterol, triglycerides, and enzyme activities of ALT and AST were measured using biochemical analyser (Abbott Diagnostics - Architect, USA).

Chemical analysis of the diets was run using the international procedures of AOAC. The data were analysed by ANOVA using the GLM procedure of SAS. Differences between the means (P< 0.05) were determined using Duncan's multiple range test. Most of the values reported for measured parameters in the present study indicated that the data are normally distributed.

Table 1. Ingredients and chemical composition of the basal diet fed to quails*

Feedstuff	**%**
Crude protein	21.50
Ether extract	7.50
Crude fiber	4.00
Crude ash	6.00
Calcium	0.90
Phosphorous	0.50
Lysine	1.30
Methionine	0.50
Trace elements	**ppm**
Manganese	120.00
Zinc	100.00
Selenium	0.30
Iron	40.00
Iodine	1.25
Cupper	16.00
Vitamins	**IU/kg**
Vitamin A	10.000,00
Vitamin D_3	5.000,00
Vitamin E	75.00

*The diet contains 100 ppm antioxidant (Narasin - Maxiban).

RESULTS AND DISCUSSIONS

Quails fed a diet supplemented with Se alone or a combination of Se+Cr resulted a decrease in live weights ($P \geq 0.0238$) (Table 2). Selenium supplementation in the diet of quails resulted in a decrease in live weight but adding Cr to the diet supplemented with Se caused alleviation in decreased live weights. Similarly, feed intake decreased in quails fed a diet supplemented with Se, but adding Cr to the diet supplemented with Se caused alleviation in decreased feed intake ($P < 0.0001$). However, feed conversion ratio did not change upon any supplementation ($P = 0.3220$).

Surplus of recommended amounts of both Se and Cr by NRC (1994) did not support live weight performance in quails. In addition, excess amounts of these elements resulted in a depressed live performance. These results were not expected because the both elements are involved in crucial functions in the metabolism of the quails. Chromium plays important role in carbohydrate metabolism. The oligopeptide low-molecular-weight chromium-binding protein (chromodulin) tightly binds four chromic ions before the oligopeptide obtains the conformation required for binding to the tyrosine kinase active site of the insulin receptor (Sun et al., 2000). The oligopeptide-chromodulin binds chromic ions in response to an insulin-mediated chromic ion flux, and the metal-saturated oligopeptide can bind to an insulin-stimulated insulin receptor, activating the receptor's tyrosine kinase activity. Thus, chromodulin appears to play a role in an auto-amplification mechanism in insulin signalling (Sun et al., 2000). In addition, the release of chromium from chromium picolinate for use in cells requires reduction of the chromic centre, a process that can lead potentially to the production of harmful hydroxyl radicals (Sun et al., 2000). However at the present work, blood glucose concentrations increased upon Cr supplementation of the diet in quails (Table 3).

It was expected to have a greater live performance of quails fed a Se-supplemented diet because Se supplementation in poultry has long been associated with energy metabolism, increased feed conversion ratio, improved reproduction, and improved immune responses. However, as was a case for Cr, Se supplementation decreased the live performance. Selenium is toxic to poultry when used in high doses (< 3–5 mg/kg feed). The dose used at the present work is not toxic enough to reduce live performance. It was also assumed that the Se dose used at the present work was not toxic enough to cause any toxicity but high concentration enough to reduce live performance, namely, feed intake, body weight gain, and feed conversion ratio.

As expected, supplementing both Se and Cr to the diet of quails increased the blood concentrations of Se and Cr ($P < 0.0001$) (Table 3). In addition, supplementing both Se and Cr to the diet of quails increased the blood concentrations of Fe and Cu ($P < 0.0001$). In general, supplementing either of the trace elements influenced the serum concentrations of the elements measured.

Table 2. Live weight performance of quails fed a diet supplemented with Se and Cr

	Treatment*				
Parameter	Control	Se	Se+Cr	SEM	*P*
Initial live weight, gr	24.633	24.300	23.066	0.6507	0.2061
Final live weight, gr	171.133^{a}	159.500^{b}	165.433^{ab}	2.945	0.0238
Live weight gain, gr	146.500^{a}	135.200^{b}	142.366^{ab}	3.037	0.0331
Feed intake, gr	332.833^{c}	340.666^{a}	337.833^{b}	0.643	<0.0001
FCR**	0.4402	0.4131	0.4214	0.013	0.3220

*a, b, c: Means in the same row with different superscripts differ ($P < 0.05$).

**Feed conversion ratio: live weight gain/feed intake.

Table 3. Changes in some serum metabolites and minerals of quails fed a diet supplemented with Se and Cr*

	Treatment**				
Parameter	Control	Se	Se+Cr	SEM	*P*
Glucose, mg/dL	278.166^{b}	278.280^{b}	308.240^{a}	7.145	0.0036
Triglyceride, mg/dL	247.208	304.760	380.000	52.694	0.2026
Cholesterol, mg/dL	192.541	190.640	199.440	5.626	0.2026
Total protein, g/dL	9.520^{a}	8.628^{a}	6.152^{b}	0.863	0.0189
ALT, U/L	5.625	6.000	5.680	0.324	0.6818
AST, U/L	438.916^{a}	386.720^{ab}	315.840^{b}	36.624	0.0587
Ca, ppm	0.0348^{a}	0.0019^{b}	0.0019^{b}	0.005	0.0009
P, mg/dL	10.813^{a}	10.048^{ab}	8.608^{b}	0.695	0.0720
Mg, ppm	0.0212	0.0023	0.0001	0.009	0.2442
Na, ppm	0.1796^{a}	0.000002^{b}	0.000002^{b}	0.009	<0.0001
Cl, mmol/L	114.608	112.080	113.200	1.469	0.4658
Al, ppm	0.005^{b}	8.719^{b}	24.810^{a}	2.909	0.0002
Mn, ppm	0.0003^{b}	0.0530^{b}	0.1798^{a}	0.0274	0.0007
Fe, ppm	0.0298^{c}	44.212^{b}	80.534^{a}	4.177	<0.0001
Cu, ppm	0.0013^{c}	0.463^{b}	0.930^{a}	0.075	<0.0001
Zn, ppm	0.1364^{a}	0.1886^{a}	0.0002^{b}	0.0307	0.0027
Se, ppm	0.0028^{c}	0.1154^{b}	0.3982^{a}	0.036	<0.0001
Cr, ppm	0.0008^{c}	0.2604^{b}	0.4730^{a}	0.028	<0.0001

*Blood samples were taken in quails starved overnight.

**a, b, c: Means in the same row with different superscripts differ ($P < 0.05$).

CONCLUSIONS

Results of the present work showed that NRC (1994) recommendations should be followed for a better performance. Any excess amounts of Se and Cr results in a depressed live performance in quails.

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