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EFFECT OF SUPPLEMENTAL CHROMIUM ON PERFORMANCE, BLOOD CONSTITUENTS AND DIGESTIVE ENZYMES ACTIVITY OF BROILER CHICKS

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ABSTRACT

An experiment was conducted to investigate the effect of feeding different graded levels of chromium chloride (Crcl₃) on performance, blood constituents and digestive enzymes activity of broiler chicks.

Two hundred and seventy day-old Hubbard broiler chicks were allocated randomly to 6 experimental treatments, 45 chicks each. All birds were fed on corn soybean basal diet supplemented with 6 graded levels of chromium chloride as 0 (control), 25, 50, 75, 100 and 125mg/kg diet.

The results indicated that, average body weighs were improved significantly by adding 25 and 50 mg $Crcl_3$ /kg diet. There were a non significant improve in feed conversion ratio (g feed / g gain). Feed consumption values were not affected by enriched $Crcl_3$ into diets. Mortality rates were dramatically reduced.

Blood contents of total lipids, cholesterol, triglycerides, and glucose were decreased as a result of $Crcl_3$ addition. Blood concentration of total proteins was increased significantly due to adding $Crcl_3$ by 75, 100 and 125 mg/kg diet, while blood albumin was significantly affected only at levels of 100 and 125 mg $Crcl_3$. Blood globulin was significantly higher than control at levels of 50, 75 and 100mg $Crcl_3$. Besides, a reduction in albumin/globulin ratio at same levels was recorded. So chromium supplementation may enhance immune function of chicks

Blood concentrations of thyroid hormones (T3 and T4) were significantly higher in treated groups than the controls. Alkaline phosphatase enzyme reduced significantly whiles the level of GOT and GPT enzyme was not affected. Amylase enzyme values were significantly elevated in stomach and duodenum, while in jejunum this effect was not clear. Lipase enzyme activity was significantly higher in duodenum and jejunum in birds treated with 75, 100 and 125mg chromium /kg diet. Trypsine and Chemotrypsin values in duodenum and jejunum were not affected.

It can be concluded that, chromium supplementation into broiler diets may enhance growth performance traits, interfere with lipid and carbohydrate metabolism and could improve the immune system responses and positively affect pancreatic enzymes activity.

Keywords: (broiler, chromium chloride, growth performance, blood constituents, digestive enzyme).

INTRODUCTION

Recently chromium is well accepted as essential element for human and animal health, due to its role as an integral component of the glucose tolerance factor (GTF). Chromium is trivalent (Cr^{+3}) bound to several molecules of niacin and amino acids to build the GTF which potentiates the action of insulin hormone (Mertz; 1969). Insulin is needed for glucose metabolism and energy production, muscle tissue protein deposition, fat deposition and cholesterol utilization (Hossain *et al.*. 1998).

In spite of, the NRC (1994) doesn't recommend the optimal value of chromium supplementation into poultry diets; recent studies indicate the beneficial effects for enriching chromium into diets. Hossain *et al.* (1998) reported that broiler chicks reared on floor pens with supplemental chromium yeast at a level of 300 mg/kg diet, had significantly higher body weight and better gain to feed ratio. Lien *et al.* (1999) observed an improvement in daily gain and feed utilization of broilers fed diets supplemented with 200 mg chromium picolinate. Sahin *et al.* (2002a) observed an improvement in body weight gain and feed efficiency ratio of heat stressed broiler chicks due to adding chromium picolinate into their diets.

As well, supplemental chromium reduced mortality rate (Kim *et al.*, 1995), enhance immune response (Uyanik *et al.*, 2002). In addition supplementation of chromium into poultry diets stimulate the secretion of digestive enzymes (Linderman *et al.*; 1995).

Chromium is available in organic and inorganic form, however most of chromium studies were conducted with the organic form (Cr picolinate, Cr yeast) and few of them were conducted with the inorganic form. Uyanik *et al.*, (2002) observed an improvement in the efficiency of feed utilization and immune function due to adding chromium chloride ($Crcl_3$) into broiler diets.

This study aimed to investigate the effect of adding different graded levels of chromium chloride into broiler diets on their performance, some blood constituents and digestive enzymes activity.

MATERIALS AND METHODS

This experiment was conducted at "Broiler Nutrition Unit" Fac. of Agric., Ain Shams University. The study aimed to investigate the effect of adding different graded levels of $Crcl_3$ into broiler chick diets on their performance, some blood constituents and some digestive enzymes.

Two hundred and seventy one-day Hubbard broiler chicks were allocated randomly into six treatment groups of 45 birds in three replicates, 15 birds each. All birds were fed on a corn-soybean basal diet supplemented with 6 graded levels of $Crcl_3$ as, 0 (control), 25, 50, 75, 100 and 125 mg/kg. diet.

Two basal diets were formulated (Table1) to meet the nutrient requirements of chicks during the starter (0-3 wk) and grower (3-6 wk) periods according to NRC (1994). The chicks were housed in floor pens with wood-shaving litter. Electrical heaters were used to obtain suitable environmental temperature and artificial lighting was provided constantly. Water and mach feed were provided ad lib.

Individual body weights were recorded weekly for each group and body weight gain was calculated for each group based on two experimental periods (0-3 and 3-6 weeks). Feed conversion ratio was calculated as gram feed /gram gain in the same manner.

Table (1):Composition and calculated analysis of the experimental diets.

Ingredient (%)	0 -3	3 - 6
Corn yellow	52.56	56.72
Soy Bean Meal 44%	35.058	31.51
Vegetable Oil	4.61	4.73
Corn Gluten Meal 60 %	3.93	3.40
Dicalcium Phosphate	1.91	1.84
Calcium Carbonate	1	0.98
Sodium Chloride	0.46	0.39
Vit. and Min. Premix*	0.3	0.3
DL- Methionine	0.137	0.125
Calculated analysis (%)		
Crude protein	22	20
M E(kcal / kg)	3100	3150
C/P ratio	140.9	157.5
Calcium	1	0.96
Phosphorus (available)	0.5	0.48
Methionine	0.5	0.45
Meth. +Cyst.	0.9	0.84
Sodium	0.2	0.17
Lysine	1.2	1.1

***Each 3 kg of vitamin and minerals mixture contain: 12000000 IU vitamin A; 2000000 IU D3; 10g E ; 1g K ; 1 g B1 ; 5g B2; 1500mg B6 ; 10mg B12 ;10g Pantothenic acid ; 20g Nicotinic acid ; 1g Folic acid ; 50mg Biotin ; 500 g choline chloride ;4 g copper ; 300 mg iodine ; 30g iron ;60 g Manganese; 50g Zinc; and 100mg selenium**

Blood constituents

Blood samples were collected in heparin zed tubes and centrifuged immediately for 15 minutes to separate plasma that was decanted and stored frozen (-20°c) upto chemical analysis.

Plasma total protein was determined according to Biuret method described by Henery (1964) and albumin according to Doumas *et al.* (1971). Plasma globulin was obtained by subtracting albumin from total protein values. Plasma total lipids was determined according to Knight *et al.* (1972) and total cholesterol according to Watson (1960). Plasma triglycerides were assayed by using kits of Diamond Diagnostics Company. Plasma Calcium and phosphorus were determined by using commercial kits of Giesse Diagnostics Company. Plasma concentrations of thyroid hormones (T_4 and T_3) were measured by radio active 125-I using radioimmunoassay technique (Diagnostic products corporation, Los Angeles, California, USA).

Plasma concentration of Glucose and alkaline phosphatase were assayed by using commercial kits of Giesse Diagnostics Company. Plasma concentration of GOT and GPT were determined by using available commercial kits Bio- Meraux, France.

Digestive enzymes activity

At the end of the experiment six birds of each treatment, representing the average group weight, were slaughtered in a horizontal position to reduce the antiperistalsis movement of the intestinal segments and regurgitation of the food.

The gut was clumped with artery forceps at the end of oesophagus, proventriculus, (stomach) jejunum, gizzard, duodenum and ileum, then the contents of the stomach, duodenum and jejunum were separately collected, weighed and kept in equal volumes of buffer saline solution. The contents were then individually centrifuged (6000 rpm for 10 min.) and the supernatant fluids were decanted and used for the determination of some digestive enzymes activity. Amylase activity was determined by using the method described by Pinchasov and Noy. (1994) lipase activity according to Skalan, *et al.* (1975) and both Trypsine and Chemotrypsin according to Skalan, and Helevy (1985).

Statistical Analysis

Statistical analysis was computerized by statistical program of SAS (1994), and Duncan's multiple range tests was used to separate means.

RESULTS AND DISCUSSION

Effect on performance aspects.

Average body weight of chicks (Table 2) were significantly higher than control due to adding 25, 50 and 75 mg chromium chloride into diets at 3 wk of age, while at 6 wk of age, a significant increase in body weight was noticed in birds fed 25, 50 and 100mg Cr-diets compared with the control, 75 and 125mg group's.

These results is in agreement with those of Sahin *et al.* (2002 a) and Lien *et al.* (1999) who observed an increment in body weight gain of birds by adding chromium into their diets. Sahin *et al.* (2002 b) related the body weight improvement to the effect of Cr in increase protein and muscles deposition.

Feed consumption values were not affected significantly by adding $Crcl_3$ into diets either at 3 or 6 week of age. This result is in harmony with those obtained by Ward *et al.* (1995) who didn't observe any effect on feed intake of chicks fed diets enriched with chromium. However, Uyanik *et al.* (2002) observed a reduction in feed intake of broiler chicks fed 20 mg/kg diets. This disagreement may be due to the differences in the levels of Cr used in the current experiment (above 25mg/kg).

Feed conversion ratio was improved by adding $Crcl_3$ into chick diets. Furthermore the level of 25mg/kg was significantly higher than control at 6 wk of age. This result is inconsistence with the findings of Kim *et al.* (1995) and Uyanik *et al.* (2002) who indicated that supplementation of chromium significantly improved feed conversion ratio of broiler chicks. Linderman *et al.* (1995) demonstrated that Cr picolinate increase amino acids uptake by muscle cells of growing pigs that may enhance protein utilization and improve feed to gain ratio.

Mortality rates were dramatically reduced as a result of supplementing $Crcl_3$ into diets. Reduce mortality rate may be related to the beneficial effect of Cr on enhancement of the immune response of broilers as reported by Hossain *et al.* 1998.

Table (2): Effect of levels of Chromium Chloride (mg) on body weight (g), feed intake (g), feed conversion ratio and total mortality rate

Items	control	25 mg/kg	50 mg/kg	75 mg/kg	100 mg/kg	125 mg/kg
body wt. (g)	724.75^{c}	803.97^{ab}	822.25^{a}	774.3^{ab}	761.73^{bc}	762.68^{bc}
(0-3wk)	±15.5	± 13.9	± 19.6	± 17	± 19	± 17.6
Final Body Wt.(g)	1977.3^{d}	2201.6^{a}	2133.4^{ab}	2011.9^{bcd}	2117.3^{abc}±	1977.6^{cd}
(0 - 6 wk)	± 43.4	± 46.9	± 48.8	± 58.9	41.3	± 48.9
feed intake (g)	1078.3	1141.1	1159.6	1133.1	1125.8	1082.6
(0-3 wk)	± 34.9	± 23.6	± 24.6	± 17.6	± 15.6	± 24.6
feed intake	4260	4296.1	4330.9	4252.5	4308.3	4147.2
(0-6 wk) (g)	± 9.2	± 9.02	± 7.5	± 5.54	± 5.5	± 4.75
Feed conversion	1.58	1.50	1.50	1.56	1.57	1.51
(0-3 wk)	± 0.05	± 0.01	± 0.06	± 0.06	± 0.01	± 0.006
Feed conversion	2.20^{a}	1.99^{b}	2.07^{ab}	2.10^{ab}	2.07^{ab}	2.10^{ab}
(0-6 wk)	± 0 .03	± 0.05	± 0.04	± 0.09	± 0.02	± 0.06
l mortality (%)	11.54	0	4.4	4.44	2.22	0

a-b within rows, means with no common superscripts differ significantly ($p \geq 0.05$)

Generally, the positive effect of supplemental chromium on body weight and efficiency of feed utilization may be related to its role in stimulating the secretion of digestive enzymes activity (see Table 4) and consequently increased the digestibility and utilization of dietary nutrients. Kornegay *et al.* (1997) stated that the digestibility of dry matter and nitrogen retention were increased by supplemental Cr in pigs, probably as a result of increases in the secretion of digestive enzymes.

Furthermore; supplemental chromium may enhance the immune response (Table3) (Uyanik *et al.* 2002) and ameliorate the negative effect of environmental stress (Sahin *et al.*, 2002b). Therefore, Cr supplementation may improve the health of chicks and consequently enhance performance traits.

Effect on some blood constituents

Lipid derivatives

Plasma contents of total lipids, cholesterol and triglycerides (Table 3) were reduced as a result of adding $Crcl_3$ into broiler chick diets. Furthermore, the reduction was significance at levels of 75, 100 and 125 mg/kg diet. The current results support the previous findings about the role of chromium in lipid metabolism. Abraham *et al.* (1982 a, b) stated that chromium is essential for lipid metabolism. As well, Chen *et al.* (2001) found a reduction in lipid parameters resulted from increasing Cr level in broiler chick diets. Uyanik *et al.* (2002), observed a reduction in blood cholesterol by increasing $Crcl_3$ levels in Japanese quail diets. Lefavil *et al.* (1993) observed a reduction in serum triglycerides by chromium supplementation into poultry diets.

Blood proteins and immunity

Plasma total proteins (Table 3) increased significantly due to adding $Crcl_3$ by 75, 100, 125 mg/kg into diets. This result confirmed the findings of

Sahin *et al.* (2002 a) who observed a linear increase in blood total proteins levels with increasing dietary supplementation of chromium.

Blood content of albumin was not affected significantly by 25, 50, 75 mg /kg chromium levels however the levels of 100, 125 mg/kg have a significant effect. Ibrahim (2005) reported that, chromium didn't alter blood content of albumin up to 50 mg/kg diet.

Blood globulin concentration of birds fed 50, 75 and 100 mg chromium / kg diets were significantly higher than control. The high concentration of globulin inherent with low ratios of albumin/globulin (A/g) may indicate an enhancement in immune function of birds fed dietary chromium. Uyanik *et al.* (2002), observed an increase in immunoglobulin levels and antibody titers of broiler fed diets supplemented with inorganic chromium.

Table (3) Effect of dietary Chromium Chloride (mg) levels on different blood parameters of broiler chicks at six week of age

	control	25 mg/kg	50 mg/kg	75 mg/kg	100 mg/kg	125 mg/kg
Total lipids (mg/dl)	4.25^{a} ±.16	3.97^{ab} ± .17	4.13^{ab} ± 0.2	3.39^{c} ± 0.09	3.38^{c} ± .04	3.66^{bc} ±.19
Cholesterol (mg/dl)	199.96^{a} ±6.2	196.81^{a} ±5.5	190.18^{ab} ±4.7	170.15^{c} ± 4.6	175.18^{bc} ±4.06	172.9^{c} ±4.7
Triglycerides (mg/dl)	232.35^{a} ±5.2	223.23^{ab} ±5	208.68^{bc} ±6.1	196.18^{c} ±5.03	191.98^{c} ±3.61	207.83^{bc} ±5.08
Total protein (mg/dl)	4.51^{c} ±.17	4.56^{c} ± 0.11	4.9^{bc} ± 0.10	5.29^{b} ±0.16	5.84^{a} ± .12	5.16^{b} ± .21
Albumin (mg/dl)	2.54^{b} ± .16	2.74^{ab} ±.09	2.66^{b} ±0 .07	2.86^{ab} ± 0.11	3.19^{a} ± .19	3.16^{a} ± .16
Globulin (mg/dl)	1.96^{cd} ± .16	1.82^{d} ± .03	2.25^{bc} ± 0.08	2.43^{ab} ± 0.1	3.65^{a} ± .11	1.998^{cd} ± .18
Albumin / Globulin ratio (mg/dl)	1.34^{ab} ± 19	1.5^{ab} ±0.04	1.19^{b} ± 0.05	1.18^{b} ± .05	1.22^{b} ± .12	1.63^{a} ± .18
T3 (mg/dl)	3.17^{c} ± .12	3.43^{bc} ± 0.09	3.75^{b} ± 0.16	4.22^{a} ± 0.13	3.87^{ab} ± .14	3.8^{ab} ±.16
T4 (mg/dl)	12.24^{c} ± .66	12.49^{bc} ± 0.35	12.34^{bc} ±0 .5	12.92^{abc} ± 0.5	14.08^{ab} ± .60	14.3^{a} ± .66
Alkaline phosphatase(mg/dl)	113^{a} ± 5.02	103.78^{ab} ±4.9	89.98^{c} ± 2.7	74.38 ± 2^{d}	78.28^{d} ± 2.5	95^{bc} ± 2.67
Calcium (mg/dl)	12^{ab} ± .48	10.88^{b} ±0 .6	11.88^{ab} ± .39	11.7^{ab} ± .4	13.1^{a} ± .3	12.58^{a} ± .4
Phosphorus (mg/dl)	3.95^{b} ± .11	4.18^{ab} ± 0.18	4.2^{ab} ± 0.15	4.05^{ab} ± 0.10	4.48^{a} ± .09	4.35^{a} ± .11
Glucose (mg/dl)	208.2^{a} ± 5.6	193.85 ± 4.7.	180.05^{c} ± 4.1	159.18^{d} ± 3.0	176.33^{c} ± 5.5	183.85^{bc} ± 3.7
GOT (mg/dl)	102.83 ±4.7^{a}	129.28^{a} ±5.6	128.95^{a} ± 5.6	97.58^{a} ± 6.8	114.65^{a} ± 8.7	111.9^{a} ± 6.1
GPT (mg/dl)	11.45^{b} ± .6	21.1^{a} ± .90	19.6^{a} ± 1.2	18.25^{a} ± 1.2	13.55^{b} ± 1.0	12.98^{b} ± .1.35

a-b within rows, means with no common superscripts differ significantly ($p \geq 0.05$)

Physiological parameters

There were a significant increase in the levels of T3 and T4 hormone for the chicks fed dietary chromium. This may be due to that thyroid hormones have a function in nutrients metabolism and utilization (Anderson, 1997b and McNamara and Valdez 2005).

Alkaline phosphatase enzyme activities were significantly reduced due to $Crcl_3$ feeding. This result disagree with those of Uyanik *et al.* (2002) who observed an increase in alkaline phosphatase of birds fed chromium supplemented diets.

Blood concentration of GOT and GPT enzyme was not affected significantly by treatments, which may reveal that the $Crcl_3$ levels used in the present study were safe for birds and had non deleterious effects on liver and kidney function of treated chicks.

There was a significant reduction in blood glucose level of chicks fed dietary chromium. Sahin *et al.* (2001) found that chromium supplementation markedly decreased blood glucose level. Jeejebhoy *et al.* (1977) and Sahin *et al.* (2001) reported that chromium is essential for glucose metabolism due to its role in glucose oxidation which is needed for converting glucose into lipid.

Blood calcium was not affected significantly by enriching Cr into diets. However, there were increases in blood phosphorus concentration due to treatments. These results are in harmony with those of Uyanik *et al.* (2002), who found an influence of chromium on phosphorus metabolism. Okada *et al.* (1989), stated that Cr supplementation have a relative effect on minerals metabolism.

Effect on digestive enzymes activity:

Amylase enzyme values (Table 4) were significantly elevated in stomach and duodenum by high level of chromium addition, while in jejunum the effect wasn't clear. Because of amylase is an pancreatic enzyme that affect carbohydrate metabolism, so chromium may activate its role to complement with insulin to induce its effect on glycolysis. Hossain *et al.* (1998) reported that, chromium is an integral component of glucose tolerance factor, which regulating energy production.

Lipase enzyme values were significantly higher than control in duodenum and jejunum due to feeding diets supplemented with chromium at 75, 100, 125 mg/kg. however, in stomach lipase enzyme values were not influenced by treatment except at level of 125mg chromium which recorded a significant effect. It is clear that, supplemental chromium may stimulate lipid metabolism throughout its effect on lipase enzyme. Steele and Rasebrough (1981) showed that trivalent chromium is involved in the lipid metabolism.

Trypsine enzyme was not affected by chromium supplementation in duodenum or jejunum while the high levels of supplemental chromium (75, 100, 125 mg) elevate the enzyme values in stomach. Chemotrypsin enzyme values were significantly similar in stomach, duodenum or jejunum except for the group of birds fed 100 mg chromium which were significantly higher than control in duodenum and jejunum. It is clear that, supplemental chromium has a low effect on protein digestion. This results disagree with the finding of Kornegay *et al.* (1997), who stated that nitrogen retention were increased by adding chromium as a result of increase the digestive enzyme in pig. This disagreement may be related to type experimental animal and age of experimental animals in both experiments.

Table (4): Effect of dietary Chromium Chloride (mg) levels on digestive enzymes activities in different intestinal segments of Broiler chicks

parameters	control	25 mg/kg	50 mg/kg	75 mg/kg	100 mg/kg	125 mg/kg
				In Stomach		
Amylase (mg/dl)	0.35[b] ± 0.05	0.38[b] ± .45	0.46[ab] ±0 .04	0.57[a] ± .06	0.57[a] ± .03	0.39[b] ± 0.04
Lipase (mg/dl)	2.05[b] ± .17	1.64[b] ± .05	1.71[b] ±0 .15	2.1[b] ± .12	1.9[b] ± .12	2.58[a] ± 0.18
Trypsine (mg/dl)	31.62[c] ±5.1	33.49[bc] ± 3.4	40.54[abc] ± 3.7	45.89[ab] ± 3.8	51.7[a] ± 4.9	45.49[ab] ± 3.6
Chemotrypsine (mg/dl)	11.72 ±.45	11.83 ±0.88	12.44 ± .88	12.73 ± .91	14.56 ± 1.6	12.79 ± 1.1
				In Duodenum		
Amylase (mg/dl)	1.35[c] ± .05	1.5[bc] ±0 .06	1.51[bc] ± 0 .07	1.65[ab] ± .03	1.81[a] ± .07	1.8[a] ± 0.03
Lipase (mg/dl)	6.15[b] ± .24	5.9[b] ± 0.25	6.94[ab] ± 0.7	6.85[ab] ± .3	8.68[a] ± .41	8.2[a] ± 1.0
Trypsine (mg/dl)	35.89 ±3.5	37.91 ± 4.08	36.18 ± 2.3	38.08 ± 1.8	45.59 ± 2.2	44.32 ±3.7
Chemotrypsine (mg/dl)	26.93[b] ± 3	28.06[ab] ± 3.2	27.91[ab] ± 1.7	28.87[ab] ± 1.4	35.64[a] ± .64	35.42[ab] ±3.0
				In Jejunum		
Amylase (mg/dl)	1.92[a] ±1.1	1.93[a] ± 0.11	2.14[a] ± 0.24	2.08[a] ± .08	2.28[a] ± .08	2.13[a] ± 0.13
Lipase (mg/dl)	7.86[b] ±.32	8.17[b] ± 0.21	8.69[ab] ± 0.55	9.45[a] ± .08	9.48[a] ± .33	9.64[a] ± 0.27
Trypsine (mg/dl)	27.33 ±1.38	28.53 ± 4.3	28.71 ± 1.3	28.55 ± 2.1	34.34 ± 2.8	31.46 ± 2.2
Chemotrypsine (mg/dl)	29.95[b] ±0.76	29.5[b] ± 1.8	32.71[ab] ± 0.24	31.84[ab] ± 2.5	39.12[a] ± 3.2	36.66[ab] ±2.8

a-b within rows, means with no common superscripts differ significantly ($p \geq 0.05$)

Generally the values of digestive enzymes in the stomach and intestine validate a role of supplemental chromium in stimulating pancreatic enzymes secretion. This conclusion is in agreement with the findings of Linderman *et al.* (1995) who proved that, supplemental chromium might affect on pancreatic B cell secretion which cause an increase in secretion of pancreatic enzymes.

Conclusion

The results of the current study showed that, supplementation of $Crcl_3$ into broiler diets have beneficial effects on their performance traits. It may interfere with carbohydrate and lipid metabolism via stimulation of pancreatic enzymes secretion.

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تأثير إضافة الكروم إلي علائق كتاكيت اللحم علي الأداء الإنتاجي، بعض خصائص الدم ونشاط الإنزيمات الهاضمة

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- أجريت هذه الدراسة لمعرفة تأثير إضافة مستويات متدرجة من كلوريد الكروم إلي علائق كتاكيت التسمين علي أداءها الإنتاجي وبعض محتويات الدم والإنزيمات الهاضمة.
- استخدمت الدراسة عدد ٢٧٠ كتكوت هبرد عمر يوم تم تقسيمهم إلي ٦ مجاميع بواقع ٤٥ كتكوت بكل مجموعة مقسمة إلي ثلاث تكرارات بكل منها ١٥ كتكوت وغذيت المجاميع علي ٦ علائق تحتوي علي ٦ مستويات من كلوريد الكروم وهي صفر (كنترول) و ٢٥ و ٥٠ و ٧٥ و ١٠٠ و ١٢٥ مجم/كجم عليقة.
- وأشارت النتائج إلي تحسن في متوسط وزن الكتكوت نتيجة لإضافة الكروم بمستوي ٢٥ و ٥٠ مجم/كجم كذلك كان هناك تحسن غير معنوي في معامل التحويل الغذائي (جم غذاء/جم نمو) بينما لم يتأثر الاستهلاك الغذائي بالمعاملات وكذلك انخفضت معدلات النفوق نتيجة للمعاملة.
- محتوي الدم من الليبيدات الكلية و الكوليستيرول والجلسريدات الثلاثية انخفض نتيجة لإضافة الكروم للعلائق.
- محتوى الدم من البروتينات ازداد معنويا نتيجة لإضافة الكروم بمستوي ٧٥ و ١٠٠ و ١٢٥ مجم/كجم عليقة بينما مستوي الالبيومين بالدم ازداد فقط نتيجة للمعاملة بـــ ١٠٠ و ١٢٥ مجم كروم/كجم.
- محتوي الدم من الجلوبيولين ازداد معنويا نتيجة لإضافة الكروم بنسبة ٥٠ و ٧٥ و ١٠٠ مجم/كجم والذي أدي إلي انخفاض في نسبة الالبيومين إلي الجلوبيولين وهذا يشير إلي تحسن المناعة نتيجة المعاملة.
- مستوي هرمونات الغدة الدرقية (T3&T4) بالدم ازداد معنويا نتيجة المعاملة التي سببت انخفاض في – مستوى إنزيم الكالين فوسفاتيز بينما إنزيمي GOT & GPT لم يتأثرا.
- مستوي سكر الدم (glucose) انخفض معنويا نتيجة المعاملة.
- ارتفع مستوي إنزيم الأميليز في المعدة و الاثني عشر نتيجة لإضافة الكروم الذي أدى إلي رفع مستوي إنزيم الليبيز معنويا في الاثني عشر والصائم بينما كان تأثيرة غير واضح علي إنزيمي التربسين والكيموتربسين.
- ويستخلص من هذه النتائج أن إضافة الكروم لعلائق كتاكيت اللحم تحسن من الأداء الإنتاجي وتؤثر في تمثيل الدهون والكربوهيدرات وربما تؤدي لتحسين الأداء المناعي للطيور وكذلك تؤدي إلي تحسن معدلات إفراز إنزيمات البنكرياس.