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# Effect of Supplementing Different Levels of Chromium Yeast to Diet on Broiler Chickens Performance

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**Abstract:** The experiment was conducted at the Faculty of Agriculture University of Ain Shams-Egypt, from January to March 2008, to study the effect of different levels of chromium yeast (Cr-yeast) on broiler chickens performance, carcass quality and enzyme activity through 35 days of experimental periods. A total of 450 one-day old unsexed chickens (Cobb) strain were used. The birds were randomly allocated to five treatments with 3 replicates each. The treatments were control (T1) without supplementation and T2, T3, T4 and T5 which were supplemented with 0.5, 1, 1.5 and 2 mg Cr-yeast /kg diet, respectively. Live body weight and weight gain were significantly ($p \leq 0.05$) higher when Cr-yeast were supplemented at 1 (T3), 1.5 (T4) and 2 (T5) mg/kg diet. Feed conversion was significantly ($p \leq 0.05$) better when Cr-yeast was supplemented at levels of 1 (T3) or 1.5 (T4) mg/kg diet. Dressing percentage, percent cuts were not affected by dietary supplementation of Cr-yeast. Amylase level in both jejunum and ileum increased significantly ($p \leq 0.05$) in the groups supplemented with 1 (T3) or 1.5 (T4) mg Cr-yeast, while other enzyme levels were not significantly different among control and supplemented groups. However, enzyme levels of supplemented groups were numerically higher than the control. Protein percentage in the breast and thigh increased significantly ($p \leq 0.05$) in all Cr-yeast supplemented groups as compared to the control group, while fat percentage in the breast and thigh decreased significantly ($p \leq 0.05$) when Cr-yeast level increased from 1-2 mg/kg diet. It can be concluded that Cr-yeast had a beneficial effect on some of the productive measurements of broilers under such experimental conditions.

**Key words:** Broiler chicken, chromium, chromium yeast, broiler performance

## INTRODUCTION

Many nutritionists have been considered chromium as an essential element for humans and animals (NRC, 1980). It involves in carbohydrate, lipid, protein and nucleic acid metabolic functions (Anderson and Kozlovsky, 1985). Chromium compounds were also found to be a blood Glucose Tolerance Factor (GTF) in rat experiments (Walker, 1993), which promotes glucose metabolism, enhances glycogenesis from glucose and accelerates glucose transport (Steele and Rosebrough, 1981), chromium is also a co-factor of insulin, promoting insulin activity (McCary *et al*., 1988), enhancing amino acid uptake, promoting lipogensis from glucose and lipid storage in the liver and adipose tissues (Steele and Rosebrough, 1979). Chromium can also reduce blood levels of lipid, total cholesterol, Low-density Lipoproteins (LDL) and increases High Density Lipoproteins (HDL) (Press *et al*., 1990). Chromium is also considered as antistress factor (Kegley and Spears, 1995) and increases immune capability (Uyanik *et al*., 2002). Chromium types (organic or inorganic) as feed supplement was very important issue and it was very critical since they affected on tissue uptake (Anderson *et al*., 1996). Chromium forms are varied in their bioavailability inside animal body (Mowat, 1997).

Therefore, a need to revaluate the efficiency of different forms of chromium (organic vs inorganic) for feed supplementation have become a necessary issue. The effect of supplemented Inorganic chromium (chromium chloride)and organic chromium (chromium yeast, chromium picolnate) in broiler chickens diets on broiler performance, carcass quality, digestive enzyme activities has been studied and revealed that chromium yeast supplementation has better results than other chromium sources (El-Kaiaty *et al*., 2005: El-Afifi, 2008: Al-Mashhadani and Ali, 2009). Yeast-bound chromium is produced by introducing an inorganic chromium source such as chromic chloride into live yeast culture. As the brewer's yeast cells grow and multiply chromium is taken up into the yeast cells, increased the chromium content of the yeast. Some yeast-bound chromium products also contain the culture from which the live yeast cells were grown. It is difficult to know the actual amount of organic chromium in the yeast cells in these products (Zinpro, 2003).

The objective of the present work to study the effect of dietary supplementation of chromium yeast at different levels on broiler performance, carcass quality and digestive enzyme activities.

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## MATERIALS AND METHODS

The experiment were conducted at Broiler Nutrition Unit, Faculty of Agriculture Ain Shams University during the period from January to March 2008.

Experimental birds were raised from day-old to 5 weeks of age. Cobb broiler chickens were randomly allocated to floor pens. Electrical heaters were used to maintain room temperature at 34°C during the first week of age and then the temperature was decreased gradually to 26°C during the 3rd week of age. Artificial lighting was provided constantly during the experimental period. Water and mash feed were provided *ad lib* through the 35 days experimental period. All chickens were vaccinated against avian influenza at one day old and Newcastle disease at 6, 18 days old.

This experiment was conducted to study the effect of adding different graded levels of chromium yeast being 0, 0.5, 1, 1.5, 2 mg/kg to broiler chickens diets on their performance, carcass quality and digestive enzymes activity. Four hundred and fifty one-day old Cobb broiler chickens were allocated randomly into five treatment groups of 90 birds and divided into three replicates with 30 birds each.

The chickens were received starter diet from one to 21 day of age and then switched to grower diet from 22-35 days of age, as shown in Table 1. The diets were formulated according to NRC (1994).

Table 1: Composition and calculated analysis of the experimental diets

| Ingredient (%) | Starter (0-3 wks) | Grower (3-5 wks) |
|---|---|---|
| Yellow corn | 55.80 | 59.71 |
| Soybean meal (44%) | 34.32 | 30.00 |
| Corn gluten meal (60%) | 3.33 | 2.80 |
| Vegetable oil | 2.79 | 4.00 |
| Dicalcium phosphate | 1.94 | 1.67 |
| Limestone | 1.14 | 1.14 |
| Common salt | 0.25 | 0.25 |
| Vit and min. premix* | 0.25 | 0.25 |
| DL. methionine | 0.18 | 0.18 |
| Total | 100.00 | 100.00 |
| **Calculated analysis** ** | | |
| Crude protein (%) | 22.00 | 20.00 |
| ME. kcal/kg | 3000.00 | 3194.00 |
| Calcium (%) | 1.00 | 0.91 |
| Available phosphorus (%) | 0.50 | 0.45 |
| Methionine + Cystein (%) | 0.93 | 0.78 |
| Lysine (%) | 1.10 | 1.10 |

*Each 3 kg of vitamin and minerals mixture contatin: 12000000 IU vitamin A; 2000000 IU D3; 10 gE; 1 gk; 1 g Bl; 5 g B2 1500 mg B6; 10 mg B12; 10 g pantothenic acid; 20 g Nicotinic acid 1 g Folic acid; 50 mg Biotin, 500 g Choline chloride; 4 g copper; 300 mg iodine; 30 g iron; 60 g manganese; 50 g zinc and 100 mg selenium.

**According to NRC (1994)

In this experiment, five different dietary treatments were used as follows:

Treatment 1 (Control) T1: The basal diet without chromium yeast supplementation, treatment 2 (T2): The basal diet + 0.5 mg Cr yeast/kg diet, treatment 3 (T3): The basal diet + 1 mg Cr yeast/kg diet, Treatment 4 (T4): The basal + 1.5 mg Cr yeast/kg diet, Treatment 5 (T5): The basal diet + 2 mg Cr yeast/kg diet.

Weekly live body weights were individually recorded for each chick and the average live body weights were calculated for each replicate and treatment during the five week experimental period.

Cumulative and interval weekly body weight gains were calculated for each chick, replicates and treatments. Feed consumption Feed conversion ratio were also recorded weekly for each replicate.

At the end of 5 weeks, four broiler chickens from each replicate were taken randomly and slaughtered. Dressed carcass were weighed and calculated as percentage of live body weight.

The dressed carcass was partitioned into breast, thigh, drumstick cuts that were weighed and calculated as percentage of dressed carcass weight.

Meat samples were taken from breast and thigh to measure the biochemical analysis including Ether Extract (EE), protein, Moisture and Ash, according to AOAC (1980).

The contents of jejunum and ileum were collected, weighed and kept in equal volumes of buffer saline solution at 35 days of age. The contents were then individually centrifuged (600 rpm for 10 min). Then the supernatant fluids were decanted and used for determination of some digestive enzymes activity.

Amylase activity was determined using the method described by Pinshasov and Noy (1994) and lipase activity was measured according to Skalan *et al*. (1975), while trypsine and chemotrypsine activities were measured according to Skalan and Helevy (1985).

Completely Randomized Design (CRD) was used to study the effect of difference treatment in all traits. Duncan (1955) multiple range test was used to compare the significant differences between means. Data were analyzed using statistical analysis system (SAS, 2001) by assuming the following model.

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where;

$Y_{ij}$ : Is the value of observation of traits.

$\mu$ : Is The overall mean of traits.

$T_i$ : The effect of treatments, control (T1), (T2), (T3), (T4) and (T5) in experiment.

$e_{ij}$ : Random error assumed to be mean equal to zero and variance is $\sigma^2 e$ ($N \sim 0, \sigma^2 e$).

## RESULTS AND DISCUSSION

The live body weight of broiler chickens in different groups during the experimental period is illustrated in

Table 2. The data showed that the body weight at 3 weeks was significantly ($p<0.05$) higher in broiler chickens which received basal diet with 0.5 mg Cr yeast (T2) and 1.5 mg Cr yeast (T4) as compared to control group, while the body weight of broiler chickens which received basal diet with 1.0 mg Cr yeast (T3) and 2.0 mg Cr yeast (T5) did not differ from the value observed in control group (T1) from one end, as well as from those values observed in 0.5 mg Cr yeast (T2) and 1.5 mg Cr yeast (T4) groups from the other end. The body weights were 707.69, 762.14, 740.71, 757.76, 743.93 g for T1, T2, T3, T4, T5, respectively at 3 weeks of age. The present data indicated that the body weight at the end of experimental periods (5 weeks of age) increased significantly ($p\leq0.05$) by adding Cr yeast to diets comparable to control group (except T2 group). The values were 1795.47, 1869.23, 1887.76, 1863.93 g for T1, T3, T4, T5, respectively. The body weight of broiler chickens which received diet with 0.5 mg Cr yeast T2 did not differ from the body weight observed in control as well as from those values observed in T3, T4, T5.

Average body weight gains of experimental groups at different ages are shown in Table 3. At the first interval (0-3) weeks, the data showed that the lowest body weight gain was recorded in control group 665.13 g, while 0.5 mg Cr yeast (T2) and 1.5 mg Cr yeast (T4) groups had significantly ($p\leq0.05$) highest body weight gain. The other two groups (T3, T5) recorded intermediate values which were not differ from the body weight gain in control group as well as from those found in T2 and T4. The values were 719.88, 715.50g for T2 and T4 mg Cr yeast respectively at 3 weeks of age.

During 3-5 weeks of age, the broiler chickens fed basal diet with 1.0, 1.5, 2.0 mg Cr yeast (T3, T4 and T5) recorded highest body weight gain (1128.52, 1130, 1120 g), respectively compared to broiler chickens which received basal diet with 0.5 mg Cr yeast (1060 g) While, the control group did not differ from the value of T2 as well as from those values of T3, T4 and T5. Statistical analysis of data showed that body weight gain was increased due to adding 1.0, 1.5, 2.0 mg Cr yeast into diet and the values were 1826.97, 1845.5, 1821.67 g respectively compared to control group (1753.47 g) at 5 weeks of age but the body weight gain of 0.5 mg Cr yeast group did not differ from that recorded in control group (T1) as well as from those values recorded in T3, T4 and T5.

The feed intake of broiler chickens in the different groups during the experimental periods is illustrated in Table 4. Statistical analysis of the obtained data showed at 3 weeks of age that there were no significant differences among the various broiler groups. The data showed that the broiler chickens which received the basal diet with 1.0 mg Cr yeast recorded lowest feed intake (1330 g) while control group and 0.5, 1.5, 2.0 Cr yeast group T1, T2, T4, T5 had higher feed intake being 1379, 1352.5, 1345, 1379.5 g, respectively. During 3-5 weeks of age, all groups supplemented with different Cr yeast levels consumed numerically less feed than the control group. The values were 2436, 2410.5, 2384.5, 2340 and 2350 g for, T1, T2, T3, T4and T5, respectively, but differences were not significant. However, total feed intake from 0-5 weeks of age revealed that Cr yeast supplemented

Table 2: Effect of Cr yeast levels on body weight (g) of broiler chickens

| Age | Treatments (Cr yeast levels) mg/kg diet | | | | |
|---|---|---|---|---|---|
| (weeks) | Control (T1) | 0.5 (T2) | 1.0 (T3) | 1.5 (T4) | 2.0 (T5) |
| 3 | $707.69^{b}\pm3.45$ | $762.14^{a}\pm2.30$ | $740.71^{ab}\pm2.88$ | $757.76^{a}\pm5.19$ | $743.93^{ab}\pm4.2$ |
| 5 | $1795.47^{b}\pm20.7$ | $1822.14^{ab}\pm35.8$ | $1869.23^{a}\pm29.4$ | $1887.76^{a}\pm38.8$ | $1863.93^{a}\pm24.1$ |

Means having different letters in the same row are significantly different ($p\leq0.05$)

Table 3: Effect of Cr yeast levels on body weight gain (g) of broiler chickens

| Age | Treatments (Cr yeast) mg/kg diet | | | | |
|---|---|---|---|---|---|
| (weeks) | Control (T1) | 0.5 (T2) | 1.0 (T3) | 1.5 (T4) | 2.0 (T5) |
| 0-3 | $665.13^{b}\pm37.2$ | $719.88^{a}\pm24.1$ | $698.45^{ab}\pm11.2$ | $715.50^{a}\pm9.1$ | $701.67^{ab}\pm22.0$ |
| 3-5 | $1088.30^{ab}\pm4.65$ | $1060.00^{b}\pm11.2$ | $1128.52^{a}\pm1.15$ | $1130.00^{a}\pm4.61$ | $1120.00^{a}\pm8.4$ |
| 0-5 | $1753.47^{b}\pm3.6$ | $1779.88^{ab}\pm4.04$ | $1826.97^{a}\pm6.2$ | $1845.50^{a}\pm4.5$ | $1821.67^{a}\pm2.7$ |

Means having different letters in the same row are significantly different ($p\leq0.05$)

Table 4: Effect of Cr yeast levels on feed intake (g) of broiler chickens

| Age | Treatments (Cr yeast levels) mg/kg diet | | | | |
|---|---|---|---|---|---|
| (weeks) | Control (T1) | 0.5 (T2) | 1.0 (T3) | 1.5 (T4) | 2.0 (T5) |
| 0-3 | 1379.00±51.8 | 1352.50±60.7 | 1330.00±70.2 | 1345.00±66.7 | 1379.50±55.7 |
| 3-5 | 2436.00±37.9 | 2410.50±55.4 | 2384.50±38 | 2340.00±28 | 2350.00±18.9 |
| 0-5 | $3815.00^{a}\pm170.1$ | $3763.00^{a}\pm191$ | $3561.00^{b}\pm120$ | $3685.00^{ab}\pm88$ | $3690.50^{ab}\pm142$ |

Means having different letters in the same row are significantly different ($p\leq0.05$)

at 1 mg/kg diet T3 reduced significantly feed intake compared to that of control group and those fed Cr yeast at 0.5 mg/kg diet T2.

Feed Conversion Ratios (FCR) for different experimental treatments were illustrated in Table 5. During the first interval (0-3) the FCR of the control (T1) group(2.07) was significantly worse than the other groups (T2, T3 and T4). Also, the differences in FCR were not noticeable among the T2, T3 and T4 groups. The values were 1.87, 1.83, and 1.88, respectively. While FCR of T5 group was better as compared to control (T1) being 1.97. There were no significant differences in FCR among supplemented group and the control group from 3-5 weeks of age. Meanwhile, FCR from 0-5 weeks of age was significantly ($p \leq 0.05$) better for T3 and T4 (1 mg and 1.5 mg Cr yeast) and the average value for these treatments were 1.94 and 1.99 respectively. Feed conversion for T5 was not significantly different from other groups. While, FCR for T3 and T4 were significantly ($p \leq 0.05$) better than T1 (control) and T2 (0.5 mg/kg).

The experiment showed an improvement in body weight and body weight gain by gradually increasing the Cr yeast level in diet, this result may be suggested that organic chromium (Cr yeast) helps insulin receptor sites on muscle cell work more efficiently. Insulin receptors on the outer part of a cell allow the cell to bind with insulin in the blood. When the cell and insulin bind signals within the cell activate glucose transporters so that the cell can then take up glucose from the blood and use it for energy. The result was a significantly improved rate at which muscles absorbed glucose from the blood and metabolized it. The improve in FCR could be due to that Cr yeast is considered the most biologically active and observable form of chromium (Naguiby, 2005).

Chromium yeast molecules either pass through the intestinal wall intact, or are broken down in the digestive system, releasing the free chromium ion for transport across the intestinal wall, chromium promoting insulin activity and thus increasing glucose transport into cell (Zinpro, 2003).

Table 6 shows the carcass yield percentage of broiler chickens in different experimental groups. Statistical Analysis of the obtained data indicated no significant ($p \leq 0.05$) differences among the different broiler chickens groups in the dressing percentage, but it is obvious that the dressing percentage of broiler chickens fed T3, T4, T5 diet was numerically higher (71.51, 71.49, 71.17%, respectively) than that of the control (T1) diet (70.18%) and T2 diet (69.62%).

The obtained data showed that thigh and drumstick percentages were not affected by treatments. Regarding the breast percentage, statistical analysis of variance didn't show any significant difference between experimental groups of broiler chickens fed different experimental diets. The values were 27.71, 28.17, 28.55, 26.7, 27.02% for T1, T2, T3, T4, T5 groups, respectively. This results are in agreement with those of Choct *et al.* (2000) and Uyanik *et al.* (2005) who observed that carcass yield percentage was not affected by Cr yeast supplementation.

Digestive enzyme activity (amylase, lipase, trypsin, and chymotrypsin) in jejunum and illum of broiler chickens fed different experimental diets are shown in Table 7. Statistical analysis of the obtained data indicated that amylase enzyme values were significantly ($p \leq 0.05$) higher than those of control in jejunum by supplementing 1.0, 1.5, 2.0 mg Cr yeast into broiler chickens diets and values were 2.46, 2.35, 2.55 µ/dl, respectively. The amylase activity of broiler chickens which received 0.5 mg Cr yeast (T2) (2.14 µ/dl) did not differ from the value recorded in control group (1.7 µ/dl) as well as from T3, T4, T5 groups.

Amylase enzyme values were significantly ($p \leq 0.05$) elevated in ileum by adding 1.0, 1.5 mg of Cr yeast and values were 2.23, 2.15 µ/dl, respectively compared to control diet (1.79 µ/dl). The amylase activity of T2, T5 group (1.98, 1.91 µ/dl, respectively) did not differ from that of the control group as well as from T3, T4 groups. Lipase enzyme values were not affected in jejunum and ileum by feeding diets with different levels of Cr yeast. It

Table 5: Effect of Cr yeast levels on feed conversion ratio (g feed/g gain) of broiler chickens

| Age | Treatments (Cr yeast) mg/kg diet | | | | |
|---|---|---|---|---|---|
| (weeks) | Control (T1) | 0.5 (T2) | 1.0 (T3) | 1.5 (T4) | 2.0 (T5) |
| 0-3 | $2.07^{a}$±0.35 | $1.87^{b}$±0.42 | $1.83^{b}$±0.40 | $1.88^{b}$±0.13 | $1.97^{ab}$±0.70 |
| 3-5 | 2.24±0.11 | 2.20±0.25 | 2.11±0.41 | 2.07±0.34 | 2.09±0.20 |
| 0-5 | $2.17^{a}$±0.05 | $2.11^{a}$±0.01 | $1.94^{b}$±0.56 | $1.99^{b}$±0.8 | $2.02^{ab}$±0.65 |

Means having different letters in the same row are significantly different ($p \leq 0.05$)

Table 6: Effect of Cr yeast on dressing and internal organs percentage of broiler chickens at 5 weeks

| Characters (%) | Treatments (Cr yeast levels) mg/kg diet | | | | |
|---|---|---|---|---|---|
| | Control (T1) | 0.5 (T2) | 1.0 (T3) | 1.5 (T4) | 2.0 (T5) |
| Dressing carcass | 70.18±16.0 | 69.62±14.39 | 71.51±11.2 | 71.49±8.12 | 71.17±3.66 |
| Thigh | 16.52±0.66 | 16.82±0.83 | 16.70±1.5 | 15.69±0.15 | 15.77±0.90 |
| Drumstick | 11.94±0.25 | 12.42±0.50 | 11.84±0.32 | 12.56±0.13 | 13.22±0.42 |
| Breast | 27.71±0.91 | 28.17±0.65 | 28.55±0.77 | 26.70±0.20 | 27.02±1.02 |

Table 7: Effect of Cr yeast levels on amylase, lipase, trypsin and chemotrypsin activities in jejunum and ileum of broiler chickens at 5 weeks of age

| Enzyme type (Unit/dl) | Treatments (Cr yeast levels) mg/kg diet | | | | |
|---|---|---|---|---|---|
| | Control (T1) | 0.5 (T2) | 1.0 (T3) | 1.5 (T4) | 2.0 (T5) |
| **In jejunum** | | | | | |
| Amylase | 1.70$^{b}$±0.6 | 2.14$^{ab}$±0.08 | 2.46$^{a}$±0.2 | 2.35$^{a}$±0.4 | 2.55$^{a}$±0.3 |
| Lipase | 9.69±0.1 | 10.30±0.4 | 11.50±0.1 | 10.00±0.09 | 11.78±0.10 |
| Trypsin | 20.74±0.22 | 25.76±0.05 | 25.40±0.38 | 20.65±0.12 | 23.19±0.20 |
| Chemotrypsine | 13.79±0.09 | 16.95±0.18 | 14.80±0.25 | 14.05±0.10 | 14.30±0.01 |
| **In ileum** | | | | | |
| Amylase | 1.79$^{b}$±0.08 | 1.98$^{ab}$±0.04 | 2.23$^{a}$±0.2 | 2.15$^{a}$±0.01 | 1.91$^{ab}$±0.17 |
| Lipase | 9.08±0.75 | 8.20±0.88 | 9.35±0.17 | 8.26±0.14 | 9.10±0.10 |
| Trypsine | 7.66±1.5 | 8.82±1.1 | 8.33±0.68 | 8.61±0.10 | 9.66±0.50 |
| Chemotrypisn | 7.94±2.6 | 7.69±3.5 | 7.83±1.8 | 6.97±0.10 | 7.92±1.32 |

Means having different letters in the same row are significantly different ($p \leq 0.05$)

Table 8: Effect of Cr yeast levels on chemical analysis of breast and thigh muscles of broilers at 5 weeks of age

| Characters (%) | Treatments (Cr yeast levels) mg/kg diet | | | | |
|---|---|---|---|---|---|
| | Control (T1) | 0.5 (T2) | 1 (T3) | 1.5 (T4) | 2 (T5) |
| **Muscle protein** | | | | | |
| Breast | 22.84$^{c}$±1.60 | 23.59$^{b}$±0.85 | 25.53$^{a}$±1.12 | 25.52$^{a}$±1.05 | 25.9$^{a}$±1.14 |
| Thigh | 19.40$^{c}$±1.20 | 20.28$^{b}$±1.74 | 21.34$^{a}$±1.43 | 21.47$^{a}$±0.8 | 21.53$^{a}$±1.1 |
| **Muscle fat** | | | | | |
| Breast | 8.20$^{a}$±0.11 | 7.40$^{b}$±0.05 | 6.52$^{c}$±0.18 | 7.10$^{bc}$±1.02 | 7.04$^{bc}$±0.92 |
| Thigh | 13.09$^{a}$±0.22 | 12.50$^{a}$±0.87 | 11.08$^{bc}$±0.65 | 10.90$^{bc}$±0.42 | 10.00$^{c}$±0.15 |
| **Muscle moisture** | | | | | |
| Breast | 67.71±0.26 | 67.79±0.58 | 66.59±1.2 | 66.00±0.32 | 65.63±0.46 |
| Thigh | 66.32±0.43 | 65.93±0.7 | 66.42±0.18 | 66.34±0.65 | 67.14±0.53 |
| **Muscle ash** | | | | | |
| Breast | 1.25±0.03 | 1.22±0.07 | 1.36±0.2 | 1.38±0.12 | 1.33±0.10 |
| Thigh | 1.19±0.04 | 1.29±0.05 | 1.29±0.3 | 1.29±0.20 | 1.23±0.30 |

Means having different letters at the same row are significantly different ($p \leq 0.05$)

was obvious that the lipase activity valuse of broiler chickens fed Cr yeast were slightly higher than those of the control diet and values were 9.69, 10.3, 11.5, 10, 11.78 μ/dl, for control (T1), T2, T3, T4, T5, respectively. In ileum, lipase activity was not affected by Cr yeast addition, also activity of trypsin and chymotrypsin was not affected by Cr yeast supplementation in jejunum and ileum.

Amylase enzyme activity became significantly high in jejunum and ileum as Cr yeast levels increased (T3, T4 and T5) because amylase is a pancreatic enzyme that affect carbohydrate metabolism so Cr yeast 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 (GTF) regulating energy production.

Chemical composition of breast muscles is presented in Table 8. Protein percentage of the breast muscle was significantly ($p \leq 0.05$) higher in broiler chickens received 1, 1.5 and 2 mg Cr yeast (T3, T4 and T5) followed by those received 0.5 mg Cr yeast (T2) compared to control group. The values were 25.9, 25.53, 25.52, 23.59 and 22.84% for treatments T5, T4, T3, T2 and T1, respectively. The protein percentage in thigh muscle recorded a similar trend as the breast muscle. The average values were 21.53, 21.47, 21.34, 20.28 and 19.4% for T5, T4, T3, T2 and T1 (control) groups, respectively. The use of Cr yeast in feeding of broiler chickens caused significant ($p \leq 0.05$) reduction in the breast muscles fat content and the highest reduction was observed in T3 group (6.52%) followed by T5, T4, T2 group compared to control (T1) group (7.04, 7.1, 7.4 and 8.2% respectively). The thigh muscle fat percentage was significantly ($p \leq 0.05$) lower in broiler chickens received 2.0, 1.5, 1.0 mg Cr yeast compared to 0.5 Cr yeast group and control group. The values were 10, 10.9, 11.08, 12.5 and 13.09% for T5, T4, T3, T2 and T1, respectively. The moisture and ash content of breast and thigh muscle did not differ significantly ($p \leq 0.05$) among treatment groups. Adding Cr yeast decreased carcass fat deposition in breast and thigh muscle. The same results were obtained by Choct *et al*. (2000) who had recorded less fat content in muscle of broiler fed diet with Cr yeast at different levels. Significant increase in muscle protein content may be attributed to the stimulating effect of protein synthesis by a supplement of chromium (Lien *et al*., 1999). In addition chromium supplementation may increase amino acids uptake into tissue (Chen *et al*., 2001).

It can be concluded that Cr-yeast had a beneficial effect on some of the productive measurements of broilers under such experimental conditions.

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