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PRODUCTIVE AND PHYSIOLOGICAL RESPONSES OF NEW ZEALAND WHITE RABBIT MALES TO DIETARY ORGANIC CHROMIUM ADDITION

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This study aimed to evaluate the effect of organic chromium element (chromium yeast) as feed additive on performance of rabbit males at pre and post-sexual maturity. A control diet was formulated with an estimated proportion of 18% crude protein and 14% crude fibre. Another three diets were formulated supplementing control diet with 1.5, 2.0 and 2.5 mg chromium yeast (Cr-yeast) /kg diet. Fifty two weaned New-Zealand White (NZW) male rabbits aged 35 days and weighing 657 ± 5.27 g were used (13 per diet) overfeeding experiment which lasted 198 days. Daily weight gain and feed intake were recorded from weaning up to 92 d of age (marketing age). At this time eight rabbits from each group were allowed to reach sexual maturity. Blood samples were collected at 120 and 150 d of age from five bucks of each group. At the age of sexual maturity several reproductive traits were also recorded.

Results revealed that *Cr-yeast addition at the highest level (2.5 mg/kg diet) significantly ($P \leq 0.05$) increased the final body weight, daily weight gain, feed efficiency and plasma testosterone concentration. The minimum puberty age was obtained by 2.5 mg Cr-yeast inclusion/kg diet. Sexual activity evaluation of rabbit bucks was not significantly affected by Cr-yeast addition. Advanced-sperm motility, alive spermatozoa and morphological normal spermatozoa were significantly ($P \leq 0.05$) increased by Cr-yeast inclusion, being optimized for 2.5 mg/kg diet.*

In conclusion, the addition of 2.5% Cr-yeast to the growing and mature NZW male rabbit diets improved growth and reproductive performance.

Key words: Rabbit males, chromium, growth performance, reproduction, semen quality.

Reproduction aspects of male rabbit play an important role in the success and profitability of rabbit breeding. The plane of nutrition given to an animal can affect libido and quality of semen produced (Togun and Egbunike, 2006). It also affects age of attaining puberty and stimulation of the hypothalamus indirectly to produce interstitial cell stimulating hormone that acts in the testicular tissue (Cogan *et al.*, 2004). Specific recommendations for rabbit bucks are not available (De Blas and Wiseman, 1998), and only some specific requirements have been established.

On the other hand, the presence of unsaturated fatty acids increases the susceptibility of spermatozoa to peroxidation, which contributes to a negative effect on semen quality (de Lamirande *et al.*, 1997 and Bansal and Bilaspuri, 2011). The high unsaturated fatty acids levels in spermatozoa membrane render these cells very susceptible to peroxidation (de Lamirande *et al.*, 1997), which degrades membrane structure, sperm metabolism and DNA integrity (Jones *et al.*, 1979). Thus, to ensure suitable sperm membrane function, it is crucial to maintain the equilibrium between the level of unsaturation fatty acids and oxidative stability (Castellini *et al.*, 2003). The more common way to increase the antioxidant stability of semen is to fortify diets with antioxidant molecules.

The benefits of Cr have been known for 50 years. However, the dietary requirements of livestock for chromium have not been defined (Suttle, 2010). There are six known sources of organic Cr compounds being, chromium-L-methionine, nicotinate, chelate, proteinate, picolinate (Cr Pic) and yeast (Cr-yeast), as reported by Zinpro (2003). Researches on animals have confirmed that Cr from organic complex is absorbed more efficiently, about 25-30% more than inorganic compounds (Olin *et al*., 1994). Chromium is also considered as anti-stress factor (Kegley and Spears, 1995) and increases immune capability (Uyanik *et al*., 2002). Furthermore, Pechova and Pavlata (2007) added that demand for Cr has been increase as a result of factors commonly referred to as stressors, especially during different forms of nutritional, metabolic and physical strain. It could promote growth, anti-weanling stress and immunity of Rex-rabbits (Huang, 2012). Therefore, it is still unclear how a chelated chromium addition for growing cattle and calves does respond under the stress condition like transportation and weaning (Ohh and Lee, 2005). Some studies suggested that organic chromium could have a potential to decrease accretion rate of carcass fat and to increase that of protein (Ohh and Lee, 2005). Also, addition of organic chromium resulted in an improved recovery to normal statuses in growth performance, metabolic response, and disease susceptibility (Anderson, 1994 and Hayirli *et al.*, 2001).

Chromium is generally considered an essential nutrient for animals; it can influence carbohydrate metabolism (Mertz, 1993 and Bunting *et al*., 1994), lipid metabolism (Steele and Rosebrough, 1981) and protein absorption and metabolism (Kornegay *et al*., 1997 and Stallings and Vincent, 2006) in various species. In addition, chromium is a co-factor of insulin, promoting insulin activity (McCary *et al*., 1988), enhancing amino acid uptake, promoting lipogenesis from glucose and lipid storage in the liver and adipose tissues (Steele and Rosebrough, 1981). Chromium (insulin Co-Factor) is therefore postulated to function as an antioxidant (Preuss *et al*., 1997).

No reliable recommendations for chromium have been published (NRC, 1977). According to our knowledge, studies on the addition of chromium-yeast to rabbit's diets under Egyptian conditions during fattening period are somewhat limited and contradictory (Malik *et al.*, 2011, Abdel-Monem *et al.*, 2013 and Ghazal, Mervat *et al.*, 2013). Kalaba (2012) showed that dietary addition of Cr-yeast at a level of 1.5 mg/kg diet improved reproductive performance of doe rabbits under heat stress. On the other hand, no mammalian studies have ever examined the effects of Cr-yeast fed to males.

Therefore, The purpose of the present study was to evaluate the inexplicit response of various productive and reproductive traits at pre and post sexual maturity of NZW rabbit males are affected by organic chromium addition as Cr-yeast as a dietary supplement. The study also aimed to establish the optimum level of Cr-yeast in diets for rabbit males.

MATERIALS AND METHODS

The study was carried out at El-Gemeza Experimental Station, belongs to Animal Production Research Institute, Ministry of Agriculture, Egypt during the breeding season from January to July, 2013. Averages of ambient temperature (AT, ^{o}C) and relative humidity (RH, %) inside building were determined weekly. Then, the temperature humidity index (THI, units) was calculated using the equation modified by Marai *et al.* (2001) as follow:

$$THI = db\ ^{o}C - [(0.31 - 0.31 \times RH) \times (db\ ^{o}C - 14.4)]$$

Where: db ^{o}C = Dry bulb temperature in Celsius, RH = Relative humidity percentage/100.

The values obtained are then classified as absence of heat stress (<27.8), moderate heat stress (27.8-28.8), severe heat stress (28.9-29.9) and very severe heat stress (>30.0).

Experimental animals and management :

Fifty two weaned New Zealand White (NZW) rabbit males aged 35 days and weighed 657 ± 5.27 g were randomly divided into four similar groups (13 each). The first group was fed *ad libitum* a commercial pelleted diet according to NRC (1977) recommendations, kept untreated and served as a control group (G_1), while the other three groups were fed the same basal diet, but supplemented with 1.5 (G_2), 2.0 (G_3) and 2.5 (G_4) mg Cr-yeast/kg diet. The Cr-yeast source contained 5.5×10^9 colony forming units (CFU) of *Saccharomyces cerevisiae* and 0.40 mg of Cr per gram. Cr-yeast was first mixed with specific amount of mineral premix and then blended with small amounts of basal diet, afterward larger amounts of basal diet were mixed until a homogeneous mixture of the diet was obtained. All the experimental rabbits were healthy and clinically free from the internal and external parasites and were kept under the same managerial and hygienic conditions according to the farm routine work. Ingredients and chemical compositions of the basal experimental diet are shown in Table 1.

Experimental procedure

The averages of daily weight gain (ADG, g/d) and daily feed intake (FI, g/d) were recorded weekly for each rabbit during the growing period (from the weaning age up to marketing age at 92 d). Feed efficiency (FE, g/g) was calculated as a ratio of g gain/g feed. At the end of this period, feeding economical efficiency (EE) was calculated according to the prices of feed ingredients, additives and rabbit meat prevailing during year 2014.

About 3 mL of blood samples were collected at 120 and 150 d of age between 08.00 and 09.00 h from the marginal ear vein of five bucks from each group. Plasma was separated by centrifugation at 3000 r.p.m. for 20 min and kept −20 0C until hormonal assay. Blood serum testosterone (T) hormone concentration of the rabbit males was determined using RIA kits (Immunotech, Beckman Coulter Co., Czech Republic) in accordance with the manufacturer's information. The analytical sensitivity was 0.025 ng/mL and intra- and inter-assay coefficients of variation for T assay were 14.8 and 15%, respectively. All samples were run in duplicate and assayed by the same operator, who was blind to the experimental situation.

At maturity, the weight and age of eight rabbit bucks from each group at puberty (first mating) were recorded. Scrotal circumference was measured by the method described by Boiti *et al.* (2005). Testicular index (length × width ×

Table 1: Ingredients and chemical compositions of the basal experimental diet.

Items	% as fed
Ingredients:	
Clover hay	40.50
Wheat bran	25.00
Yellow corn	14.00
Soybean meal (44%)	11.00
Molasses	3.00
Vinasse	3.00
Bone meal	1.75
Calcium carbonate	0.70
Sodium chloride	0.55
Vitamins and mineral premix [1]	0.35
DL-Methionine	0.15
Total	**100**
Calculated chemical composition[2]:	
Ash	7.8
Crude protein	18.0
Ether extract	3.0
Crude fiber	14.0
Digestible energy, kcal/kg[3]	2720

[1] Vitamins and minerals premix per kilogram diet contains:
Vit. A, 6000.0 IU; Vit. D, 900.0 IU; Vit. E, 40.0 mg; Vit. K_3, 2.0 mg; Vit. B_1, 2.0 mg; Vit. B_2, 4.0 mg; Vit. B_6, 2.0 mg; Vit. B_{12}, 10.0 µcg; Nicotinic acid, 50.0 mg; Biotin, 50.0 µcg; Folic acid, 10.0 mg; Choline chloride, 250.0 mg; Zinc, 50.0 mg; Manganese, 85.0 mg; Iron, 50.0 mg; Copper, 5.0 mg; Iodine, 0.2 mg; Selenium, 0.1 mg; Cobalt, 0.1 mg.

[2] According to NRC (1977) for rabbit's requirements.

[3] Digestible energy (kcal/kg DM)= 4253 - 32.6 CF (% DM) – 114.4 Ash (% DM). According to Fekete and Gippert (1986).

depth) was calculated in cubic centimeters as recorded by Castellini *et al.* (2006). At 6 and 7 months of age, semen was collected artificially twice a week from eight bucks from each group during the experimental period by means of an artificial vagina as described by Boiti *et al.* (2005). Immediately after collection, semen ejaculate volume (mL), advanced sperm motility (%), alive spermatozoa (%), morphological normal spermatozoa (%), acrosomal damages (%), sperm-cell concentration (N×106/mL) and total-sperm output

(N×106/ejaculate) were estimated according to Boiti *et al.* (2005) and Castellini *et al.* (2006). Libido (sexual desire) was assessed in terms of reaction time in seconds estimated from the time of introducing doe to the buck until the buck started to mount (Castellini *et al.*, 2006). Mating activity (frequency of mating within 15 minutes) was determined using sexually receptive does.

Statistical analysis :

Data of the experiment was statistically analyzed by ANOVA test according to SPSS (2013) computer program using the following fixed model:

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

Where: Y_{ij} = Observation of the j^{th} rabbit in the treatment i; μ = Overall mean, common element to all observations; α_i = Effect of the treatments (i = 1, 2, 3 and 4); e_{ij} = Random error component assumed to be normally distributed. Data presented as percentages were transformed to the corresponding arcsine values (Warren and Gregory, 2005) before being statistically analyzed. All data are presented as least squares means ± standard error. For all data analyses, each animal was considered as an experimental unit.

RESULTS AND DISCUSSION

Climatic conditions:

Averages of AT, RH and THI during the whole experimental period are shown in Table 2. The THI data clearly indicated an absence of heat stress conditions (less than 27.8) during weaning or pre-puberty periods. While during the post-puberty period rabbit bucks exposed to moderate heat stress according to estimated THI value (28). It was suggested that the optimal temperature humidity index for the rabbit husbandry is 27.8 (Marai *et al.*, 2002).

Growth performance:

The effect of treatments on performance during the growing period (35-92 days) is shown in Table 3. The final BW at 92 d, ADG and FE values of growing NZW were significantly ($P\leq0.05$) increased as dose of Cr-yeast increased, being optimized in G_4 group. These results are in agreement with the findings of Malik *et al.* (2011); Huang (2012); Abdel-Monem *et al.* (2013) and Ghazal, Mervat *et al.* (2013) on rabbits. On the other hand, these results are different than what has been observed by Lambertini *et al.* (1999 and 2004) and Şahün *et al.* (2001) who showed that chromium-yeast addition did not affect daily gain, and feed

Table 2: Averages of ambient temperature (AT, ^{o}C), relative humidity (RH, %) and temperature humidity index (THI, units) during weaning, pre-and post puberty periods.

Periods	Months	AT (^{o}C)	RH (%)	THI (Units)
Weaning	January 15	18.5 ± 0.50	72.0 ± 1.00	18.1 ± 0.44
	February	20.8 ± 0.25	71.3 ± 0.48	20.2 ± 0.22
	March 12	22.5 ± 0.50	69.5 ± 0.50	21.7 ± 0.44
	Average	**20.6 ± 0.56**	**71.0 ± 0.46**	**20.1 ± 0.51**
Pre-puberty	March 13	23.5 ± 0.27	69.0 ± 0.46	22.6 ± 0.52
	April	25.3 ± 0.31	68.7 ± 0.66	24.2 ± 0.47
	May	27.6 ± 0.33	68.5 ± 0.68	26.3 ± 0.55
	Average	**25.3 ± 0.29**	**68.6 ± 0.59**	**24.2 ± 0.48**
Post-puberty	June	29.0 ± 0.43	71.0 ± 0.61	27.7 ± 0.46
	July	29.5 ± 0.29	71.0 ± 0.57	28.1 ± 0.56
	Average	**29.3 ± 0.48**	**71.0 ± 0.66**	**28.0 ± 0.48**

Table 3: Effect of chromium-yeast inclusion on growth performance and economical efficiency of growing NZW rabbit males during growing period.

Items	Treatments			
	G_1	**G_2**	**G_3**	**G_4**
Body weight (g):				
Initial body weight at 35 d (g)	658±11.34	658±11.34	659±11.34	659±11.34
Final body weight at 92 d (g)	1855±44.3^{c}	1974±51.5^{b}	1975±41.8^{b}	2044±55.2^{a}
Daily weight gain (g)	21.0±0.54^{c}	23.1±0.62^{b}	23.1±0.51^{b}	24.3±0.65^{a}
Feed intake (g):				
Daily feed intake (g)	99.2±1.77	99.1±2.44	99.2±2.15	99.2±2.18
Feed efficiency (g/g)	0.212±0.003^{c}	0.233±0.005^{b}	0.233±0.005^{b}	0.245±0.006^{a}
Economical efficiency:				
Total feed intake /rabbit (kg)	05.65	05.65	05.65	05.65
Price/kg diet (LE)[1]	02.60	02.63	02.64	02.65
Total feed cost/rabbit (LE)	14.69	14.86	14.92	14.97
Price/kg body weight (LE)	22.00	22.00	22.00	22.00
Selling price (L.E/ head)	40.81	43.43	43.45	44.97
Net profit of each head[2]	21.12	23.57	23.53	25.00

Means within the same row bearing different letter superscripts (a, b, c) are significantly different ($P \leq 0.05$)

[1] The price was calculated on the base of ingredients price through the experimental period; L.E = Egyptian pound.

[2]Net profit of each head = [Price of rabbit meat/ head – (cost of feed during fattening period + 5 "Considering each head coasted 5 L.E included rent, mortality, all managerial efforts, …..etc.")].

conversion during fattening period of rabbits. Despite that the results have been ambiguous; most authors agree that Cr addition during periods of increased stress (weaning stress) has a positive effect on weight gain. Also, the positive effect of treatment on weight gain can be discussed from view point mentioned by Gaythaman *et al.* (2002) who showed that increasing of testosterone concentration in blood circulation improved protein synthesis, muscles development and consequently increased weight gain. On the other hand, the insignificant effect on FI by adding Cr-yeast with FE improvements may be due to an increase in the efficiency of nutrition absorption and/or nutrients utilization.

The trend of final live BW result could be a reflection of FE, which was better for the rabbits in treated groups than those in control group. Accordingly, increases in growth performance parameters for treated groups compared to control group might be due to increased conversion of glucose to acetyl-coA (Steele and Rosebrough, 1981). Acetyl coenzyme A is an important molecule in body metabolism that used in many biochemical reactions (Fatland, 2005). The highest value of final BW due to 2.5 mg Cr-yeast treatment might be attributed mainly to involve chromium in stimulating the biological activity of insulin by increasing the insulin-sensitive cell receptors or binding activity (McCary *et al*., 1988). They were also indicated that insulin can stimulate anabolism and inhibit catabolism. On the other hand, chromium (postulated to be antioxidants) have a protective effect on pancreatic tissue against oxidative damage (Preuss *et al.,* 1997), they may help pancreas to function properly including secretions of digestive enzymes, thus improving retention of nitrogen and minerals (Hassan *et al.*, 2009).

Data concerning economical evaluation are summarized in Table 3. The present results indicated an improvement in net profit for rabbits fed diets containing different levels of Cr-yeast (G_2, G_3 and G_4) compared to those fed diets with no addition (G_1). The highest value of net profit due to Cr-yeast addition was observed in G_4, being 25.0 L.E. While the net profit values in G_2 and G_3 was nearly similar (23.5). These results showed that Cr-yeast addition had a positive effect on the economical efficiency.

Finally, the results of this section of the study provide an effective approach to improve the productive performance of male NZW rabbits at a higher net profit of each head through short-term dietary supplementation of organic chromium.

Plasma testosterone concentration:

Table 4 showed that values of plasma testosterone concentration were significantly higher ($P \leq 0.05$) in rabbits with 2.5 mg Cr-yeast/kg than those in

Table 4: Effect of chromium-yeast inclusion on some reproductive traits of NZW rabbit bucks.

Items	Treatments			
	G_1	**G_2**	**G_3**	**G_4**
Testosterone, ng/ml[1]	2.05±0.25[b]	2.15±0.20[b]	2.11±0.39[b]	3.84±0.40[a]
Weight at puberty, g	2655±18.21	2666±19.55	2744±20.41	2692±20.13
Age at puberty, days	168.0±1.62[a]	167.2±1.55[a]	160.5±1.25[b]	160.0±1.22[b]
Testicular index, cm^3	4.42±0.22[b]	4.45±0.20[b]	5.14±0.24[a]	5.22±0.26[a]

Means within the same row bearing different letter superscripts (a, b) are significantly different ($P \leq 0.05$).
[1] Average value of analysis recorded at 120 and 150 d.

other groups. However, this higher value is still within the normal range. Plasma testosterone concentration values in 1.5 and 2.0 mg Cr-yeast groups (G_2 and G_3) did not differ than that of control (G_1) group. The increase in plasma testosterone concentration with the higher Cr level might be attributed mainly to the increase in sexual accessory glands activity with treatments that can affect the secretion of testosterone from the interstitial tissues of testes (Al-Sobayil and Khalil, 2002). There is no literature available on Cr-yeast effects on testosterone levels.

Age and weight at puberty and testicular index:

Addition of Cr-yeast by the two highest levels (G_3 and G_4) caused significant ($P \leq 0.05$) decreases in age at puberty by about 4.5 and 4.8%, respectively (Table, 4). The high body weight observed in rabbits for G_3 and G_4 groups could explain the early onset of puberty in these groups. This finding came in agreement with Boulbina *et al.* (2012). Also, these results may be due to the effect of Cr in improving testosterone concentration which lead to earlier maturity age. Similar results were obtained by Samia *et al.* (2005) who found that age at puberty was related to testosterone hormone concentration. Also, Castro *et al.* (2002) mentioned that testosterone is needed to initiate spermatogenesis at puberty and for the maintenance of this process in the adult.

El-Sherbiny (1994) found that the onset of puberty involves appearance of first spermatozoa in the caudal epididymis of male rabbits. In addition, nutrition during growth affects age at puberty and indirect stimulation of hypothalamus to produce interstitial cells stimulating hormone that acts in the testicular tissue (Cogan *et al.,* 2004). Moreover, the testicular index significant ($P \leq 0.05$) increased as levels of Cr increased (Table 4) obtaining a maximum value for a 2.5 mg Cr/kg diet. Testicular size is the best primary assessment of spermatogenesis, since the tubules and germinal elements account for approximately 98% of the testicular mass (Sherines and Howards, 1978). Also, testicular index reflects spermatogenesis and testosterone production (El-Mougy *et al.*, 1991). Organic chromium inclusion had no effect on weight at puberty that was on average 2689 g.

Sexual activity:

As can be seen in Table 5, insignificant differences were found among all experimental groups for the two sexual activities (libido and mating activity). This result pointed out that buck rabbits could tolerate the addition of organic chromium as Cr-yeast up to 2.5 mg/kg diet without any deleterious effects on sexual activity. There is no literature available on Cr-yeast effects on sexual activity. However, in perspective, Cr appears to be an essential trace element because it potentiates insulin action (Mertz, 1981). In addition, Mertz *et al.* (1974) hypothesized that Cr forms a complex between insulin and insulin receptors that facilitates the insulin-tissue interaction. Moreover, Anderson *et al.* (1994) reported that suboptimal Cr intake in human led to detrimental changes in glucose, insulin and glucagon of subjects with slightly impaired glucose tolerance. Generally, such positive discriminatory effectiveness almost affect positively on sexual activity and reproductive properties.

Table 5: Effect of chromium-yeast inclusion on sexual activity of NZW rabbit bucks.

Items	**Treatments**			
	G_1	**G_2**	**G_3**	**G_4**
Sexual desire –libido-, sec.	23.10±1.11	22.16±1.09	24.09±1.08	24.88±1.12
Mating activity[1]	03.81±0.15	04.02±0.10	04.10±0.11	03.94±0.12

Means within the same row bearing different letter superscripts (a, b, c) are significantly different (P≤0.05).
[1]No. of mated during 30 minutes.

Semen production:

The sperm-cell concentration significant (P≤0.05) increased as dietary concentrations of Cr-yeast increased, the highest value being obtained by using 2.5 Cr-yeast (Table 6). However, the significant increases in sperm-cell concentration was not matched with insignificant change in semen-ejaculate volume and total-sperm output.The data indicated that there was no significant

Table 6: Effect of chromium-yeast inclusion on semen production of NZW rabbit bucks.

Items	Treatments			
	G_1	G_2	G_3	G_4
Semen-ejaculate volume, ml	0.621 ±0.02	0.655 ±0.01	0.562 ±0.01	0.600 ±0.03
Sperm-cell concentration, N × 10^6 / ml	451.77 ±22.15^c	500.77 ±24.05^b	523.31 ±22.86^b	570.15 ±27.16^a
Total-sperm output, N × 10^6 / ejaculate	422.00 ±12.12	415.11 ±15.10	400.32 ±10.07	437.00 ±18.06

Means within the same row bearing different letter superscripts (a, b, c) are significantly different (P≤0.05).

differences between supplemented groups and the control group in semen-ejaculate volume. As in the previous trial of Horky *et al.* (2012), the semen-ejaculate volume of bears was not affected by organic chromium (CrPic) dietary inclusion. In both treated and untreated rabbits, levels of semen-ejaculate volume, sperm-cell concentration and total-sperm output are within the normal range of rabbit bucks (El-Kholy *et al.*, 2008). In addition, the non-significant difference in semen volume as the supplementation level of Cr-yeast increases was in agreement with the findings of (Ogbuewu *et al.*, 2013) who indicated that secretory functions of the accessory sex glands are very sensitive to dietary changes and that the slight changes in feed chemical composition goes a long way in influencing the semen volume.

Semen concentration in this study increases with the increasing level of Cr-yeast. This indicates that there is possibility for high fertility rate due to the number of spermatozoa available at the time of copulation or insemination.

Physical semen characteristics:

The effect of Cr addition on physical semen characteristics of buck rabbits was so clear, where such additive caused significant (P≤0.05) increases in advanced-sperm motility, alive spermatozoa and morphological normal spermatozoa (Table 7). The highest increase in advanced-sperm motility due to Cr-yeast addition was observed in G_3 and G_4 being 10.3 and 16.5%, 7.5 and 8.8% and 7.5 and 10.2%, respectively. Similarly, G_3 and G_4 recorded the highest values for alive spermatozoa and morphological normal spermatozoa. While these values in G_1 and G_2 were nearly similar. On the other hand, addition of Cr-yeast caused significant (P≤0.05) decreases in acrosomal damage values in G_3 and G_4; by about 19.8 and 19.4 %, respectively (Table, 7)

Table 7: Effect of chromium-yeast inclusion in the diet on physical semen characteristics of NZW rabbit bucks.

Items	Treatments			
	G_1	**G_2**	**G_3**	**G_4**
Advanced-sperm motility, %	54.55 ±1.47^c	56.53 ±2.07^c	60.17 ±2.09^b	63.53 ±2.21^a
Alive spermatozoa, %	67.11 ±1.22^b	68.32 ±1.33^b	72.11 ±1.38^a	73.00 ±1.38^a
Morphological normal spermatozoa, %	69.24 ±1.53^c	70.26 ±1.55^c	74.41 ±1.45^b	76.33 ±1.51^a
Acrosomal damages, %	18.71 ±0.61^b	17.71 ±0.59^b	15.00 ±0.45^a	15.08 ±0.44^a

Means within the same row bearing different letter superscripts (a, b, c) are significantly different ($P \leq 0.05$).

Effects on sperm concentrations and motility observed in our trial are in agreement with those reported by Fields *et al.* (1979) who observed in young bulls that sperm concentration was positively correlated with motility and testicular size. The decrease in acrosomal damages in treated groups could be attributed to the antioxidant effect of chromium as a co-factor of insulin which can protect the plasma membrane that surrounds the acrosome and the tail. Thus, the improvements in semen quality could be attributed to the increasing of oxidative stability status. Accordingly, it seems that Cr-yeast may display an indirect role in rabbit spermatogenesis.

Also, improvement of semen quality due to Cr-yeast treatment may be related to increase of testosterone levels in treated groups; hence, testosterone is required for the maturation of male germ cells and sperm quality (Walker, 2009).

Conclusively, from these results, it could be concluded that dietary addition of chromium yeast to rabbit males exerted benefits on the growth performance of growing rabbits, this leads to positive effect on reproductive performance of mature rabbits. From the economic point of view, 2.5 mg Cr-yeast/kg diet is recommended for growing and mature rabbits. Histopathological, hematological and endocrinology studies in the same respect may be needed.

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الاستجابة الإنتاجية والفسيولوجية لذكور الارانب النيوزيلندي الأبيض للتغذية بإضافة الكروم العضوي

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تهدف هذه الدراسة الي تقييم اضافة عنصر الكروم العضوي (خميرة الكروم) للعليقة علي أداء ذكور الأرانب قبل وبعد النضج الجنسي. لذا تم استخدام ثلاثة مجاميع من الاضافات لعليقة الكنترول بـ ١,٥ و ٢ و٢,٥ مجم من خميرة الكروم لكل كجم عليقة. وقد أُستخدم اثنان وخمسون ذكر أرنب نيوزيلندي أبيض عمر فطام ٣٥ يوم بمتوسط وزن ٦٥٧± ٥,٢٧ جم (١٣ ذكر لكل مجموعة) في هذه التجربة التي أستمرت لمدة ١٩٨ يوم. وتم تسجيل زيادة الوزن وإستهلاك العلف اليومي من الفطام حتي عمر ٩٢ يوم (عمر التسويق). وفي هذا العمر أُتيح لعدد ٨ ذكور من كل مجموعة أن يصلوا للنضج الجنسي. تم تجميع عينات الدم عند عمر ١٢٠ و ١٥٠ يوم من خمسة ذكور لكل مجموعة. وسجلت أيضا العديد من الصفات التناسلية في عمر النضج الجنسي .

أوضحت النتائج أن إضافة خميرة الكروم عند أعلي مستوياته (٢,٥ مجم/كجم عليقة) كان له تأثيراً معنوياً (عند مستوى ٥%) لزيادة وزن الجسم النهائي وزيادة الوزن اليومي والكفاءة الغذائية. وكذلك زيادة تركيز هرمون التستسترون في البلازما عند ١٢٠ و١٥٠ يوم من العمر. وكان الحد الأدني لعمر البلوغ واضحاً بإستخدام نسبة ٢,٥% خميرة الكروم مقارنة بمستويات الإضافة الآخرى وكذا الكونترول. ولم يكن هناك تأثيراً معنوياً لتقييم النشاط الجنسي لذكور الأرانب متأثرة بإضافة خميرة الكروم. وكانت الحركة التقدمية والشكل المورفولوجي الطبيعي للحيوانات المنوية مرتفعة معنوياً (عند مستوى ٥%) بزيادة إضافة خميرة الكروم وكانت أقصاها عند إضافة ٢,٥ مجم/كجم عليقة.

التوصية: نستنتج من هذه الدراسة أن إضافة خميرة الكروم لعلائق ذكور الأرانب النامية حفز الأداء الإنتاجي لها مما أدى إلى تأثير إيجابي على الأداء التناسلي للذكور البالغة. ومن الناحية الإقتصادية فإنه يوصى بإضافة خميرة الكروم بمستوى ٢,٥ملجم/كجم عليقة لذكور الأرانب.