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THE ACTION OF CHROMIUM, INSULIN OR THEIR COMBINATION ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF RABBIT DOES AND THEIR OFFSPRING.

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ABSTRACT

To determine the effect of supplemental chromium picolinate (CrP) and insulin or their combination on reproductive performance of NZW rabbit does and growth performance of their offspring, 25 mature does and 5 bucks were used in this study. Does were divided into 4 groups, G1 (N=5, control), G2 (n=7, daily oral dose from CrP (18 µg CrP/kg LBW for two weeks), G3 (n=6, i.m. injected with 8 U insulin/doe/injection, twice at ٧ day-interval), and G4 (n=7, 9 µg CrP/kg + 4 U insulin/doe/injection). All treatments were two weeks pre-insemination, while the experimental period lasted up to 3 wk post-partum of the 1st litter. Rabbits were fed *ad. libitum*, on commercially pelleted diet (17%CP and 12.3 MJ ME/kg). Does in each group were naturally mated with untreated sexually mature bucks. Live body weight (LBW), feed intake (FI), milk produced (MP) of each doe was recorded during three successive weeks post-partum. Blood samples were collected at the end of the experimental period. Results revealed that during the treatment period (2 weeks), FI decreased (P<0.05) in G2 and was not affected in G3 and G4 compared with the control group. During post-partum (1-2 or 2-3 wk), FI decreased (P<0.05) in G2 compared with G3 and G4, but did not differ significantly from the control group. There was insignificant effect of treatment on LBW of does during treatment weeks or at 3 wk post-partum. In blood serum, concentration of Cr increased (P<0.05) by 16% in G2 (1.311 ppm), modest in G4 (1.144 ppm), and the lowest in G3 (0.889 ppm), which did not differ significantly from that in the control group (0.811 ppm). Concentration of glucose decreased (P<0.05) in G2, G3 and G4 as compared to the control group by about 20.6, 14.8 and 20.8%, respectively. The effect of treatment on concentration of creatinine or T3 and T4 in blood serum was not significant. Activity of AST and ALT was higher (P<0.05) in all treatment groups than in the control group. Milk produced from rabbit does was higher (P<0.05) in G3 (213.6 g/doe) than in other groups (186.2-199.5 g/doe). Conception rate was higher (P<0.05) in G3 and G4 (100%) than in G2 and control groups (85.7 and 60%) after the 1st service and was 85.7 and 80% as cumulative rate after the 2nd service. Number of services per conception (NS/C) was lesser (P<0.05) in G3 and G4 than in the control group (1 service in each vs. 1.40 in control). Does in G2 showed lesser NS/C (1.14 services/conception) than the control group and greater than G3 and G4, but the differences were not significant. Litter size at birth was 8.5, 7.5, 7.0 and 4.5/litter in G3, G4, G2 and control group. Average total litter weight per doe was the highest (P<0.05) for does in G3, followed by G4 and the lowest in G2 and control groups.

In conclusion, treatment of doe rabbits with two injections of insulin (8 U/doe) or 9 µg CrP/kg + 4 U insulin/doe/injection), ٧ days apart had beneficial effects on reproductive performance of NZW does in term of increasing litter size and growth performance of their offspring in term of increasing litter weight.

Keywords: Rabbit, chromium, insulin, reproduction, blood, growth performance.

INTRODUCTION

Chromium (Cr) is intimately involved in lipid, carbohydrate and protein metabolism and is therefore postulated to function as an antioxidant because it is an insulin potentiator (Preuss *et al*., 1997) and it is essential for activating certain enzymes and for stabilizing proteins and nucleic acids (Linder 1991).

Several studies have shown that dietary chromium picolinate (CrP) supplementation can improve performance and increased the plasma insulin concentration of laying hens (Sahin *et al*., 2001). Also, Cr has been suggested to have positive impacts on reproduction (Mooney and Cromwell, 1995). In rabbits, glucose produced by enzymatic digestion is one of the primary energy substrates, beside volatile fatty acids produced by caecal fermentation. Improvement in glucose tolerance after Cr supplementation is the most sufficient means to determine if Cr is limiting insulin responsiveness. Previous Cr researches in rabbits has been conducted in growing rabbits (El-Ayek *et al*., 2009), rabbit does (Hamed, 2005) and rabbit bucks (Nasif, 2008). Chromium potentiates the action of insulin (Davis and Vincent, 1997 and Matthews *et al*., 2001).

One of the theories (Lindemann, 1996) assumes reproduction can be affected by changing sensitivity to insulin. Most attention has been devoted to studying the effect of Cr on reproduction in pigs. Cr supplementation to sows has a positive effect on reproduction cycle (Lindemann *et al*., 1995 a&b), being in depends on doses of Cr (Lindemann *et al*., 2004). However, the information on the combination effect of CrP and insulin on reproductive performance of rabbit does are not available in the literature. Currently, there is no established Cr requirement for rabbits at different physiological stages. Consequently, the objective of this study was to determine the effect of supplemental CrP and insulin or their combination on reproduction of rabbit does and their offspring.

MATERIALS AND METHODS

The present study was carried out at Animal Production Department, Faculty of Agriculture, Mansoura University. The experimental work was carried out in Rabbit Farm, belonging to Misr Textile Company, El-Mahalla El-Kobra city, Gharbiah governorate, during the period from January to May 2008.

Animals and experimental groups:

Twenty five mature New Zealand White (NZW) does having about 6.0 months of age and average body weight (LBW) of 2917± 89.21 kg as well as 5 NZW bucks having about 6.0 months of age and 3 kg LBW for natural mating of does in different groups were used in this study. All does and bucks were healthy, sexually mature and clinically free from external parasites.

Does were divided into four groups, those in the 1st group (n=5) were served as control without any treatment. During treatment period of two weeks, does in the 2nd group (n=7) were given daily oral dose from chromium

picolinate (CrP) at levels of 18 µg/kg LBW for two weeks according to Hamed (2005). Does in the 3rd group (n=6) were i.m. injected with insulin (8 units/doe/injection) twice at ٧-day interval according to Unan (2004). However, those in the 4th group (n=7) were given daily oral dose from CrP at levels of 9 µg/kg LBW beside twice injections with insulin (8 U/doe/injection) at 14 day-interval. All treatments were two weeks pre-insemination, while the experimental period lasted up to 3 wk of age for bunnies obtained from the 1st litter.

Housing system:

Rabbits were housed in wire-cages (59 x 55 x 39 cm) arranged in two rows along the long axis of the rabbitry with two passages of suitable space for management and service. All cages of does and progeny were equipped with feeders made of galvanized metal and have nipples for automatic drinking. Light in the housing was allowed 14-16 hours per day during the period of the study, urine and faces dropped from the cages on the floor were cleaned every day in the morning. All experimental bucks and does were kept under the same managerial, hygienic and environmental condition.

Feeding system:

All rabbit does, bucks and produced bunnies were kept under similar managerial conditions during the experimental period. Animals were fed *ad. libitum*, on commercially pelleted diet. Ingredient and calculated chemical composition of the pelleted diet is presented in Table (1).

Table (1): Ingredients and chemical analysis of complete feed diet used in rabbit feeding.

Ingredient	%	Ingredient	%
Barley grain	21	Molasses	3
Wheat bran	25	Salt	0.5
Berseem hay	30	Limestone	1.2
Soybean meal (44% CP)	19	Premix*	0.3
Calculated chemical analysis:			
Crud protein (CP)	17%		
Metabolizable energy	12.3 MJ ME/kg		
Dry matter (DM)	90%		

*** One kg of premix contained 2.0 x 10^6 IU Vit. A; 8.33 g Vit. E; 15 x 10^4 IU Vit. D_3; 0.33 g Vit. K; 0.33 g Vit B_1; 1.0 Vit. B_2; 8.33 Vit B_5; 0.33 g Vit B_6; 1.7 g Vit. B_{12}; 3.33 g Pantothenic acid; 0.83 Folic acid; 33.0 mg Biotin; 200 g Choline; 0.5 g Copper; 12.5 g Iron; 11.7 g Zn; 16.6 mg Se; 66.7 mg Mg and Carrier $CaCO_3$ to 1 kg.**

Experimental procedures:

Live body weight and feed intake:

Live body weight (LBW) of does in all groups was recorded at 0, 1 and 2 of treatment period and at 3 wk post-partum. However, LBW of bunnies was recorded at the first three weeks of suckling period. While, feed intake as fed was recorded for the intervals (0-1 wk) and (1-2 wk) of treatment and (1-2 wk) and (2-3 wk) post-partum.

Blood sampling:

Blood samples were collected before feeding from the ear vein of five rabbits in each group into test tubes at the end of the experimental period (3

wk post-partum). Thereafter, blood serum was separated by centrifugation at 3000 rpm for 15 min and was stored for analysis at –20oC. In blood serum, concentration of Cr (Chang *et al*., 1992), glucose (Trinder, 1969), creatinine (Wilding *et al*., 1977), T3 (Sterling, 1975) and T4 (Liewendahl, 1990). While activity aspartate (AST) and alanine (ALT) transaminases were determined according to Reitman and Frankel (1957).

Mating and pregnancy:

Rabbit does in each group were naturally mated with untreated sexually mature bucks after two weeks of starting treatment. Pregnancy was diagnosed by palpation 10-12 days post-mating to detect the pregnant does. Doe that failed to conceive were reinseminated and then number of services per conception was calculated. After the positive mating the nest boxer was supplied with sawdust on day 25 of pregnancy to provide a comfortable and warm nest for bunnies. Within 12 hours after kindling, litters were checked, recorded and stillbirth were removed, afterwards, litters were examined each morning during the suckling period to remove the dead ones from the nest.

Milk production:

Average weekly milk production of each doe was recorded at three successive days during each week by differences between LBW of bunnies of each doe before and after suckling.

Statistical analysis:

The obtained data was statistically analyzed according to Snedecor and Cochran (1982) using computer programme of SAS system (2001). However, the significant differences among treatment groups were carried out using Multiple Range Test of Dancan (1955).

RESULTS AND DISCUSSION

Feed intake:

Results in Table (2) revealed significant ($P<0.05$) effect of treatment on feed intake of does at different treatment and post-partum weeks. During the 1st week of treatment period, only does in Cr group showed significantly ($P<0.05$) lower feed intake than those in the other groups. This reduction in feed intake was about 9.5% as compared to the control group. During the 2nd week of treatment period, does in Cr group also significantly ($P<0.05$) decreased feed intake compared with the control group, but does in INS and Cr+INS groups significantly ($P<0.05$) increased feed intake by about 8 and 7% as compared to the control group, respectively. During the treatment period (2 weeks), only does in Cr group significantly ($P<0.05$) showed the lowest feed intake compared with those in the other groups.

During post-partum weeks (1-2 or 2-3 wk), also does in Cr group showed significantly ($P<0.05$) the lower feed intake than other treatment groups (INS and Cr+INS groups), but did not differ significantly from that in the control group. Also, both INS and Cr+INS groups did not differ significantly from that in the control group (Table 2).

Table (2): Feed intake of rabbit does in different experimental groups during treatment period

Interval	Experimental group				SEM
	Control	Chromium	Insulin	Cr+INS	
0–1 wk of treatment	150.0[a]	135.7[b]	158.5[a]	157.8[a]	2.727
1–2 wk of treatment	150.0[b]	143.5[c]	162.1[a]	160.7[a]	2.314
Mean (0–2 wk)	150.0[a]	139.6[b]	160.3[a]	159.3[a]	2.341
1–2 wk Post-partum	166.0[ab]	161.5[b]	188.2[a]	172.8[a]	3.602
2–3 wk post-partum	182.0[ab]	168.2[b]	197.4[a]	187.1[a]	6.071

[a, b and c]: **Means denoted within the same row with different superscripts are significantly different at P<0.05. Cr: Chromium. INS: Insulin.**

In agreement with the present results, Matthews *et al*. (2001) reported decreases in average daily feed intakes of growing-finishing swine supplemented with 200 ppm CrP during the growing phase. But during the finishing phase, no significant effect was observed on feed intake. In contrast to rabbits, increasing dietary supplemented Cr significantly increased feed consumption of broiler (Lien *et al.,* 1999 and Sahin *et al*., 2002a), laying Japanese quail (Sahin *et al.,* 2002b) and turkey males (Chen *et al.,* 2001). In one study available on NZW rabbits treated with insulin, Unan (2004) found that feed intake of doe rabbits treated with insulin was not affected by treatment as compared to the control.

Changes in live body weight:

Results in Table (3) concerning changes in live body weight (LBW) of rabbit does revealed insignificant effect of treatment on LBW of does during treatment weeks or at 3 wk post-partum, although does in Cr group showed the lowest LBW as compared to other groups at all experimental intervals.

Interestingly to note that the reduction in LBW of does in Cr group during treatment period could be attributed to the reduction in their feed intake.

Table (3): Changes in live body weight of rabbit does in different experimental groups during treatment time and post-partum.

Interval	Experimental group				SEM
	Control	Chromium	Insulin	Cr+INS	
Live body weight of rabbit does:					
0 time	2920.0	2907.1	2914.2	2907.0	84.18
1 wk of treatment	3027.1	2907.1	2971.4	3000.0	73.77
2 wk of treatment	3075.7	2958.2	2975.0	3078.6.	72.51
3 wk post-partum	3135.7	3033.3	3050.0	3221.4	77.77

There are no significant differences among experimental groups or at all experimental periods. Cr: Chromium. INS: Insulin.

Most investigators mentioned that Cr supplementation did not affect average daily gain during the finishing phase of pigs (Matthews *et al*., 2001), calves (Kegley *et al*., 1997) and steers (Kegley and Spears, 1995). On the other hand, Pitler *et al*. (2003) published results of a meta-analysis whose aim was to assess the evidence of the effect of chromium picolinate for

reducing body weight. They suggest arelatively small effect of cr picolinate compared with the placebo for reducing body weight.

Blood parameters:

Results in Table (4) show that Cr concentration significantly (P<0.05) increased by about 16% in blood serum to maximal values (1.311 ppm) in Cr group, the modest in Cr+INS group (1.144 ppm), and the lowest in INS group (0.889 ppm), which did not differ significantly from that in the control group (0.811 ppm). These results are logic and in accordance with level of Cr treatment in different treatment groups. In this respect, El-Ayek *et al*. (2009) found similar values of control group fed similar diet to that fed in this study. Also they observed similar trend of increasing Cr concentration in serum of Cr treated than in control rabbits by about 15%. Also, Anderson *et al*. (1989) reported that Cr concentrations of breast, liver and kidney linearly increased with the increasing organic Cr supplementation. Sahin *et al*. (1996) found that levels of Cr increased in the serum of sheep grazed plants.

As expected, glucose concentration in blood serum significantly (P<0.05) decreased in Cr, INS and Cr+INS groups as compared to the control group by about 20.6, 14.8 and 20.8%, respectively. It is of interest to note that the rate of reduction in glucose concentration was higher in Cr or Cr+INS groups than in INS group, which may indicate important role of Cr in carbohydrate metabolism. The observed decrease in glucose concentration in Cr treated rabbits was proven by El-Ayek *et al*. (2009) in serum of rabbits and indicated in plasma of turkey (Chen *et al.,* 2001) and broilers (Uyanik *et al.,* 2002). In this line, Cupo and Donaldson (1987) reported that dietary Cr supplementation increased rate of glucose utilization in liver tissue, which explains the decrease in glucose levels obtained in this study. Chromium is generally accepted as the active component in the glucose tolerance factor, which increases the sensitivity of tissue receptors to insulin, resulting in increased glucose uptake by cells (Abraham *et al.,* 1992). Furthermore, Anderson *et al.* (1991) suggested Cr involvement in carbohydrate metabolism including glucose uptake, glucose utilization for lipogenisis, and glycogen formation.

On the other hand, the effect of treatment on concentration of creatinine or T3 and T4 in blood serum was not significant (Table 4). Similarly, Chen *et al*. (2001) reported that dietary Cr supplementation at 1 mg Cr/kg diet to male turkey diets for 14 weeks did not significantly influence serum creatinine, but increasing Cr supplementation up to 3 mg Cr/kg significantly increased creatinine concentration at 22 weeks of age. Also, Shinde and Goyal (2003) reported that concentration of creatinine in serum of healthy rats treated with CrP were not significantly different from those of the controls.

The effect of treatment on activity of AST and ALT in serum of rabbits was significant (P<0.05). Activity of AST and ALT was significantly (P<0.05) higher in all treatment groups than in the control one.

Generally, values of all blood parameters studied are within the normal range of rabbits as reported by El-Ayek *et al*. (2009).

Table (4): Concentration of chromium, creatinine, glucose, T3 and T4, and activity of AST and ALT in blood serum of rabbit does in different experimental groups at the end of treatment.

Parameter	Experimental group				SEM
	Control	Chromium	Insulin	Cr+INS	
Biochemical concentration:					
Chromium (ppm)	0.811[c]	1.311[a]	0.889[c]	1.144[b]	0.039
Glucose (mg/dl)	102.3[a]	81.2[b]	87.2[b]	81.0[b]	2.703
Creatinine (mg/dl)	1.222	1.211	1.267	1.189	0.053
Hormonal concentration (ng/ml):					
T3	2.766	2.533	2.788	2.744	0.181
T4	40.97	42.22	43.88	43.51	2.310
Enzymatic activity (U/l):					
AST	20.4[b]	30.2[a]	30.2[a]	33.1[a]	0.885
ALT	10.8[b]	18.5[a]	18.6[a]	19.8[a]	0.553

[a, b and c]: Means denoted within the same row with different superscripts are significantly different ay P<0.05. Cr: Chromium. INS: Insulin.

In contrast to the present results, El-Ayek *et al*. (2009) showed significant (P<0.05) decrease in activity of AST and ALT in serum of treated growing rabbits (males and females) as compared to the control ones. This effect may be due to age and/or sex of rabbits in our study. In our study mature does were However, Shinde and Goyal (2003) reported that activity of AST and ALT in serum of healthy rats treated with CrP were not significantly different from those of the controls.

Milk production:

Results in Table (5) show that overall mean of milk intaked by bunnies produced from rabbit does in different experimental groups was affected significantly (P<0.05) treatment of does, being higher in INS groups than in other treated and control groups. Such finding may indicate the beneficial effect of insulin treatment on mammary gland of rabbit does in comparison with Cr treatment. The role of insulin in control of mammogenesis received very little attention and yet contradictory results have been obtained. Forsyth (1971) concluded that insulin is required to maintain mammary tissue cultured *in vitro* through stimulating mitosis. Bulmain and Folley (1951) found that insulin markedly stimulated *in vitro* lipogenesis in non-ruminant mammary glands.

Kumaresan and Turner (1965) found that insulin synergized exogenous oestrogen and progesterone to promote increased mammary development. Schmidt (1971) stated that insulin is required for the initiation of DNA synthesis but not to the rate by which DNA is replicated.

Table (5): Milk produced from rabbit does in different experimental groups during suckling period.

Suckling period (wk)	Experimental group				Overall mean
	Control	Chromium	Insulin	Cr+INS	
1st	146.250	136.250	157.500	149.167	147.291[c]
2nd	183.750	183.750	195.833	185.833	187.291[b]
3rd	268.750	238.750	287.500	253.333	262.083[a]
Overall mean	199.583[b]	186.250[b]	213.611[a]	196.111[b]	-

[a, b and c]: Means denoted within the same column or row with different superscripts are significantly different ay P<0.05. Cr: Chromium. INS: Insulin SE was 0.039, 0.034 and 0.068 for group, period and their interaction.

Insulin is also involved in protein synthesis in mammary gland explants by affecting ribonucleic acid (RNA) synthesis. Mayne *et al*. (1966) stated that only with insulin is the RNA synthesis enough to maintain its normal level in the tissue. Results of Forsyth (1971) postulated that amounts of insulin less than the optimal amounts may limit gland growth. They treated groups of rats with alloxan, which causes destruction of the beta cells of the pancreas (insulin secreting cells) causing diabetes. They found in such rats that the mean amount of DNA in their mammary glands was reduced by 18% below that of the normal control group. By replacement therapy with three units of insulin, a similar group of alloxan-treated rats showed a highly significant increase of 66% in their mammary DNA content in comparison with the group without insulin.

In addition, Ahren and Jacobsohon (1956) showed that injections of long-acting insulin combined with a carbohydrate-rich diet *ad labium* and administration of oestrogen and progesterone, promoted mammary gland growth in hypophysectomized-castrated female and male rats. For this reason, it is possible that the favorable effect of insulin on mammary gland growth in normal animals may be due, in part, to increased feed consumption. On the other hand, Topper and Freeman (1980) reported that although insulin stimulates mitosis of mammary gland *in vitro*, it is not absolutely essential for mammary growth *in vivo*. They found that severely diabetic mice treated with oestrogen and progesterone develops extensive mammary lobule-alveolar structures without any insulin treatment. The importance of adrenal cortex hormones for mammary gland growth and development has been the interest of many investigators.

The recorded insignificant increase in milk yield of rabbit does regard to Cr treatment disagreed with the finding of Hamed (2005) and Nasif (2008), who found that milk yield significantly increased in does treated with 9 µg/doe/day for NZW, V-line and California rabbit does, respectively. Also in dairy cows, Al-Saiady *et al*. (2004) found that adding chelated chromium to the diet of dairy cows under heat stress improved milk yield and feed intake without affecting milk components

Results in Table (5) show that overall mean of milk intaked by bunnies was affected by suckling period, whereas it significantly ($P<0.05$) increased by increasing suckling period, being the highest at the 3rd week of the suckling period. This trend was observed in all experimental groups. The effect of interaction between experimental group and lactation week on milk yield was not significant, but was the highest in INS group, moderate in INS+Cr group and control group and the lowest in Cr group.

Reproductive performance:

The effect of treatment on conception rate (CR) was significant ($P<0.05$), being higher in both INS and Cr+INS groups (100%) than in Cr and control groups (85.7 and 60%) after the 1st service and was 85.7 and 80% as cumulative rate after the 2nd service in the two later groups. Consequently, the effect of treatment on number of services per conception (NS/C) was significant ($P<0.05$), being lesser in INS and Cr+INS groups than in the control group (1 service in each vs. 1.40 in control). However, does in Cr group showed lesser NS/C (1.14 services/conception) than the control group

and greater than INS and Cr+INS groups, but the differences were not significant (Table 6).

In accordance with improving NS/C in Cr treated group, Nasif (2008) found insignificantly higher NS/C in rabbit does treated with 9 µg/kg than the control group (1.07 vs. 1.11). The observed improvement in NS/C for does in INS or Cr+INS groups is in agreement with the finding of Matamoros *et al*. (1990), who found that insulin administration has several positive effects on improving maturation of ovarian follicles in swine.

Inspite the pronounced improve in CR and NS/C occurred in both INS and Cr+INS groups, litter size (LS) at birth was significantly (P<0.05) the highest in INS group (8.5/litter), ranked the second in Cr+INS and Cr groups (7.5 and 7.0/litter, respectively), and the lowest in the control group (4.5/litter, Table 6).

Table (6): Reproductive performance of rabbit does in different experimental groups.

Item	Experimental group				
	Control	Chromium	Insulin	Cr+INS	
No. of inseminated does	5	7	6	7	-
Conceived does after 1st service	3	6	6	7	-
Conceived does after 2nd service	1	-	-	-	-
CR (%) after 1st service	60	85.7	100	100	-
CR (%) after 1st service*	80	85.7	100	100	-
Number of services/conception	1.40^{b}	1.14^{ab}	1.00^{a}	1.00^{a}	0.04
Litter size at birth (n)	4.5^{c}	7.0^{b}	8.5^{a}	7.5^{b}	0.21

a, b and c: Means denoted within the same row with different superscripts are significantly different ay P<0.05. Cr: Chromium. INS: Insulin. * Cumulative rate. CR: Conception rate

Such trend may reflect the highest impact of INS treatment on LS of rabbit does. However, does treated with Cr alone or in combination with INS exhibited significant (P<0.05) increase of LS in comparison with the control group. It is of interest to note that the highest LS in rabbit doe in INS group was associated with highest milk production in this group.

In agreement with increasing LS in Cr treated group, Nasif (2008) found significantly higher LS in rabbit does treated with 9 µg/kg than the control group (6.78 vs. 5.41/litter). Also, Hamed (2005) indicated significant increase in LS at birth, being 6.8 and 10.6 for 9 µg/doe/day; 8.8 and 8.5 for 18 µg/doe/day versus 5.8 and 7.0 in the controls. The LS at 21 days was 6.0 and 7.3 for 9 µg/doe/day; 5.0 and 5.0 for 18 µg/doe/day versus 4.6 and 2.7 for the control. The LS at 28 days was 6.0 and 7.3 for 9 µg/doe/day; 4.7 and 4.8 for 18 µg/doe/day versus 4.4 and 2.7 for the control, for NZW and V-line, respectively.

Lindemann, (1996) reported that the effects of Cr supplementation to sow positively affected total operational nitrogen balance by reducing nitrogen charges per pig. Improvements in litter size are associated with lower nitrogen charges per pig with the largest reduction occurring with the increased litter size. It is well established that, supplementation of CrP for humans significantly enhanced insulin sensitivity. It was found that insulin administration has several positive effects upon ovarian function, including an

increase in ovulation rate and improving maturation of ovarian follicles in swine (Matamoros *et al*., 1990). Cr supplementation to sows during the reproduction cycle has had a positive effect on LS at birth of sows (Lindemann *et al*., 1995 a&b).

The present results indicated somewhat beneficial effect of INS injection on fertilization and conception rate of rabbit does, which may result in increasing number of litter size per season.

Growth performance of bunnies:

The effect of treatment on LBW at suckling weeks was significant (P<0.05). Average total litter weight per doe was significantly (P<0.05) the highest for does in INS group, followed by that in Cr+INS group. While average total litter weight per doe was significantly (P<0.05) the lowest in Cr and control groups. The marked increase in litter weight of does in INS and Cr+INS groups was attributed to the higher growth rate of bunnies with acceptable viability rate during different suckling period as compared to the control group. However, the marked reduction in litter weight of does in Cr group was associated with acceptable growth rate and low viability rate as compared to the control group.

Such results indicated nearly similarity in growth performance of bunnies produced from rabbit does in all treated does and those in the control group, but the superiority of does in INS and Cr+INS groups was mainly related to viability rate of bunnies throughout the suckling period. Similar reduction in growth rate of NZW and California bunnies produced by does treated with Cr at two levels as compared to the controls was reported by El-Ayek *et al*. (2009) and Nasif (2008), respectively.

Table (7): Average and total live body weight of bunnies produced from rabbit does in different experimental groups during different weeks of the suckling period.

Period	Experimental group				SEM
	Control	Chromium	Insulin	Cr+INS	
At birth	223.7^{c}	331.0^{b}	475.5^{a}	439.6^{a}	27.5
1st week	325.0^{b}	311.7^{b}	630.8^{a}	485.0^{ab}	75.2
2nd week	980.0^{b}	922.5^{b}	1645.8^{a}	1184.1^{b}	145.2
3rd week	1085.0^{b}	1150.0^{b}	1885.0^{a}	1585.0^{ab}	222.1

$^{a, b \text{ and } c}$: Means denoted within the same row with different superscripts are significantly different ay P<0.05. Cr: Chromium. INS: Insulin.

In accordance with the present results, Lindemann *et al*. (2004) found that supplemental CrP increased the number of pigs born live per litter, but decreased individual birth weight of total pigs born, being 1.61, 1.57, 1.47, and 1.56 kg for levels of 0, 200, 600, 1000 ppb as-fed basis, respectively. On the other hand, In one study available on NZW rabbits treated with insulin, Unan (2004) found that rabbits treated with insulin showed the lightest weight at 5 months of age (1895.0 g) and the heaviest weights at 6 months of age (2456.0 g) as compared to control does (2064.3 and 2444.2 g, respectively). Average daily gain of doe rabbits treated with insulin was significantly (P<0.05) the lowest (8.4 g/d) during 4-5 months of age and the highest during 5-6 months of age as compared to those in the control group

In conclusion, treatment of doe rabbits with two injections of insulin (8 U/doe) or 9 µg CrP/kg plus 4 U insulin/doe/injection), ٧ days apart or had beneficial effects on reproductive performance of NZW does in term of increasing litter size and growth performance of their offspring in term of increasing litter weight.

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تـأثير الكـروم والأنسـيولين أَو كليهمـا معـا علـى الأداءِ الأنتـاجى والتناسـلى لانـاث الأرانبِ ونسلَهم

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أجريت هذة الدراسة لبحث تاثير أضافة الكروم أوالانسولين أوكليهما معا على الاداء الانتاجى والتناسلى لاناث أرانب النيوزيلاندى الأبيض وعلى معدل نمو نسلها. تم استخدام ٢٥ انثى وخمسة ذكور بالغة جنسيا فى هذه التجربة وتم تسكين الامهات فى أربعة مجموعات (المجموعه الاولى المقارنه ن=٥)، (المجموعه الثانية تعطى يوميا ١٨ ميكروجرام كروم عن طريق الفم لمدة اسبوعين ن=٧)، (المجموعة الثالثة حقنت مرتين عضليا ب٨ وحدات انسولين بينهما ٧ أيام ن=٦) (المجموعة الرابعة أعطيت ٩ ميكروجرام كروم+٤ وحدات انسولين (ن=٧)، وأستمرت جميع المعاملات لمده اسبوعين قبل التلقيح ولمدة ثلاث أسابيع بعد الولادة. تم تغذية الارانب على عليقة تجارية محببة (بروتين ١٧%- وطاقة ١٢.٣ ميجا جول) الى حد الاشباع. تم تلقيح الامهات فى جميع المجموعات طبيعيا من الذكور البالغة وتم تقدير وزن الجسم الحى ومعدل استهلاك العلف خلال فترة المعامله و محصول اللبن الأسبوعى خلال فترة الرضاعه وتم جمع عينات الدم فى المراحل المختلفة. وتشير النتائج الى أنه خلال الفترات المختلفة للمعاملة انخفض معدل استهلاك العلف فقط فى المجموعه الثانية ولايوجد أى تأثير فى المجموعة الثالثة والرابعة مقارنة بالمجموعه الكنترول، أما خلال فترة ٢-١ و٣-٢ أسبوع بعد الولادة أنخفض معدل استهلاك العلف فى المجموعات المعاملة (الثانية -الثالثة - الرابعه) ولم يوجد فروق معنوية مقارنة بمجموعة الكنترول. زاد تركيز الكروم بمعدل ١٦% للمجموعة الثانية (١.١٣١١ جزء فى المليون) وكان بمتوسط ١.١٤٤ جزء فى المليون فى المجموعه الرابعه، وأنخفض فى المجموعة الثالثه الى ٠.٠٨٨٩ جزء فى المليون ولم يختلف معنويا عن المجموعة المقارنه (٠.٨١١ جزء فى المليون). أنخفض تركيز الجلوكوز فى المجموعة الثالثة والثانية والرابعة بمعدل ٢٠.٦، ١٤.٨ و٢٠.٨% مقارنة بالكنترول. لم يكن هناك فروق معنوية فى تركيز الكرياتينين وكل من هرمونى T3 & T4 فى سيرم الدم. أرتفع محصول اللبن من أمهات المجموعة الثالثة (٢١٣.٦ جرام/ام) عن باقى المجاميع (الكنترول والثانية والرابعة) وكان ١٨٠.٤، ١٨٦.٢ و١٩٩.٥ جرام/أم، على التوالى. أرتفع معدل الاخصاب بعد أول تلقيحة فى المجموعة الثالثة والرابعة (١٠٠%) عن المجموعة الثانية والكنترول (٨٥.٧ و٦٠%، على التوالى) وكان معدل الاخصاب بعد ثانى تلقيحة ٨٥.٧ و٨٠% للمجموعة الثانية والكنترول. كان عدد التلقيحات اللأزمه للأخصاب أقل فى المجموعة الثالثة والرابعة (تلقيحه واحده) عن الثانيه والكنترول (١.١٤ و١.٤٠ تلقيحه). وكان معدل حجم البطن لكل أم أعلى فى المجموعة الثالثة (٨.٥/أم) يليها المجموعة الرابعة (٧.٥/أم) واقلها المجموعة الثانية (٧.٠/أم) ثم الكنترول (٤.٥/أم).

تشير النتائج الى أن حقن الارانب بالانسولين بمفردة بمعدل ٨ وحدات مرتين بينهما ٧ أيام أوالتجريع اليومى بالكروم بمعدل ٩ ميكروجرام لمدة أسبوعين مع ٤ وحدات حقن مرتين بالأنسولين بينهما ٧ أيام أدى الى تحسين الاداء الانتاجى والتناسلى وكذلك وزن النتاج للأرانب.

قام بتحكيم البحث

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