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Protective Effects of Vitamin E, Zinc and Selenium Supplementation on Growth Performance and Some Biochemical Parameters in Growing Rabbits Exposed to Cadmium

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ABSTRACT

The current study was carried out at Kafr El-Sheikh Governorate during 2016 to investigate the effect of using three water quality; Nile water (Abou-Omar, W1), mixed Nile and polluted drainage water (El-Bana, W2) and polluted drainage water (Kafr Dokhmeis, W3) in irrigation of agricultural land on accumulation of Cd in clay soil and berseem grown thereon and subsequently in growth performance of rabbits fed on diets contaminated with cadmium at same level of cadmium in this berseem. The role of Selenium (Se),Vitamin E (Vit. E), or Zinc (Zn) as antioxidants and as detoxifying against cadmium chloride ($CdCl_2$) was studied in 120 growing APRI rabbits. Rabbits were classified into six groups. Rabbits of the treatment 1(T1) served as diet as a control diet contained 0.10 mg cadmium (Cd) on DM basis. Treatment 2 (T2): Fed contaminated diet to provide final level of 0.96 mg Cd, Treatment (3): Fed diet supplemented with cadmium chloride plus vitamin E (150 mg/kg diet). Treatment 4 (T4): Fed diet supplemented with cadmium chloride plus Se (0.2 mg/kg diet). Treatment5 (T5): Fed diet supplemented with cadmium chloride plus Zn (100 mg/kg diet) and Treatment6 (T6): Fed diet supplemented with cadmium chloride plus 150 mg vit E plus 0.2 mg Se plus 100 mg Zn /kg diet). The results showed that polluted drainage water (W3) recorded the highest concentrations of Cd followed by W2, while W1 had the lowest concentrations. Moreover, berseem samples grown in soil irrigated with W3 showed the highest Cd content followed by berseem grown in soil irrigated with W2, while berseem grown in soil irrigated with W1 had the lowest contents. Cadmium chloride treated group showed significantly a decrease in growth performance and nutrient digestibility while supplementation with vit. E , Se or Zn alone or in combination to the contaminated diet significantly improved all these growth parameters. In the contaminated diet with Cd (T2), many large disturbance occurred in all measured blood constituents, while supplementing vit E , Se or Zn alone or in combination to the same diet, significantly improved these blood constituents. Moreover, vitamin E, Se and Zn combination showed more efficacy than vit. E, Se or Zn alone.

Keywords: antioxidants, cadmium , detoxification, growth, blood, rabbits

INTRODUCTION

Cadmium is the most dangerous environmental pollution as it's also unique due to its toxicity and its little excretion from the body (Kour *et al.,* 2014 and Olgun, 2015). On the other hand, we can find it in nature, soils, air and water system. In fact it is produced by the burning fossils fuels and metal refining (Chen *et al.*, 2008 and Kour *et al.,* 2014). You can find a lot of cadmium in soils because of agriculture activates (e.g. sewagesludge, phosphate fertilizers, and pesticides) all of them contain a lot of cadmium (Abdo and Abdulla, 2013). So it is considered as one of the carcinogen (IARC, International Agency For Research on Cancer, 1993) and it is half- life in the human kidney is 18 to 33 years (Gail *et al.*, 1982). When animals or human absorb it its excreted in little amounts. So the body does great effort to stop its entry to the human food –chain. Maximum tolerable levels of dietary cadmium for avian species were set at 0.5 mg/kg diet (El-Deek *et al.,* 2010). There are a lot of adverse effects of toxic cadmium as kidney damage, anemia , behavioral responses, energy metabolism, adrenal hypertrophy and cardiac. Some studies see that the cadmium no effect on the bone , but other studies say that cadmium causes renal dysfunction which effect on the skeletal (Whelton *et al.,* 1997a &b). The inactivation of enzymes and functional proteins cause the general toxic effect of heavy metal by directly binding to them (Tsuji *et al.,* 2002).

Stohs and Bagchi (1995) reported that oxidative damage partially by formation of reactive oxygen species (ROS). Oxidative stress developing with the production of can lead to the development of many pathological changes (Morakinyo *et al*. 2012). For example, Cd has been attributed to the formation of reactive oxygen species (Bharathi *et al*. 2012). Superoxide dismutase, catalase and glutathione peroxidase (antioxidant enzymes) protect cellular homeostasis from oxidative damage by reactive oxygen species generated through the reduction of molecular oxygen (Sanz *et al.* 2002). Antioxidants decrease ROS-induced damage (El-Demerdash, 2004). Se is an essential trace element for humans and animals, which prevents the cells against oxidative damage by the expression of selenoprotein genes and through anti-inflammatory mechanisms (Said *et al*. 2014). It is an integral component of the cytosolic enzyme GPx and facilitates the action of Vit. E in decreasing peroxy radicals (Kaneko 1989). Se has protaction effect on many heavy metals (Diplock *et al*. 1986). Vit. E (α-tocopherol) is a naturally occurring, potent lipid-soluble, chain-breaking antioxidant. It protects cellular membranes and lipoprotein surfaces from lipid peroxidation (Al-Othman *et al*. 2011). Its protective role has been reported against the heavy metal toxicity in experimental animals (Agarwal *et al.* 2010). Synergistic effect of antioxidants such as vit. E, Se , Zn and is the most powerful in decreasing storage and toxicity of reactive oxygen species (Aslam *et al*. 2010). Antioxidant addition has a protective role in metal toxicity. Therefore, the current study aims to investigate the effect of environmental pollution, represented in soil, irrigation water containing heavy metals, on the growth and production of Egyptian clover; a common fodder plant in Egypt. It also investigates the potential accumulation of cadmium in the berseem, which may cause health risk for animals and humans through the food chain. Also, the current work aimed to study the effect of Vit E, Se or Zn on growth performance, some blood constituents , lipid peroxidation (MAD) and antioxidant enzyme activities (

CAT and GSH) of serum of growing rabbits fed diets contaminated by Cd.

MATERIALS AND METHODS

Detection of Cd concentration in berseem, clay soil and water collected from different areas

The present study was carried out at Kafr El-Sheikh Governate during 2016 to investigate the effect of using three water quality sources; Nile water (Abou- Omar, W1), mixed Nile and polluted drainage water (El-Bana, W2) and polluted drainage water (Kafr Dokhmeis, W3) in irrigation of agricultural land on accumulation of cadmium in the soil and berseem grown thereon. Representing samples of water, soil and berseem were collected from the studied areas for cadmium determination. Water and soil clay samples were collected and analyzed by the same way using aqua regia method described by Cottenie *et al.* (1982). Berseem samples was prepared for cadmium determination according to AOAC (1990).

Animals and feeding system:

The current work was carried out at the Agriculture Research Center Rabbits, Animal Production Research Institute, Farm of Sakha Station, Egypt. At total of 120 growing APRI rabbits were randomly distributed into six groups of 20 rabbits each (10 females + 10 males) at 5 weeks of age were used in this study. Rabbits were housed in individual cages (60 x 50 x 35 cm) in a well ventilated (with open windows and ventilating fans building). Fresh water was automatically available all the time by stainless steel nipples. All rabbits were raised under the same managerial, hygienic and environmental conditions.

The basal experimental diet was formulated and pelleted to cover the nutrient requirements of rabbits according to the available nutrients as shown in Table 1. The experimental groups were as follow:

Treatment 1 (control): fed basal diet containing 0.1mg cadmium (Cd) on DM basis.

Treatment 2: fed basal diet contaminated with cadmium chloride (1.08 mg/kg diet) to provide Cd content of 0.96 mg (as indicated from Cd content of berseem from contaminated areas at Kafr El-Sheikh Governorate) (contaminated diet).

Treatment 3: fed contaminated dietplus 150mg vit. E /Kg diet.

Treatment4: fed contaminated dietplus 0.2 mg organic selenium / Kg diet.

Treatment5: fed contaminated dietplus 100 mg organic zinc / kg diet.

Treatment6: fed contaminated dietplus 150mg vit. E - 0.2 mg Se – 100mg Zn /Kg diet.

Source of different additives:

Heavy Metals: Cadmium was supplied as cadmium chloride ($CdCl_2$; 99% purity)

Table 1. Chemical constituents of the basal diet.

Ingredients	%	Chemical composition (% as DM):	%
Barley grain	24.60	DM	85.81
clover hay	30.05	CP	17.36
Soybean meal (44% CP)	17.50	OM	91.42
Wheat bran	21.50	CF	12.37
Molasses	3.00	EE	2.230
Limestone	0.95	Digestible energy(DE, kcal/kg)(2)	2412
Salt	0.30	Methionine(2)	0.454
Di-calcium phosphate	1.60	Lysine(2)	0.862
Mineral-vitamin premix(1)	0.30		
DL-Methionine	0.20		
Total	100		

(1) Vitamins and Minerals per kilogram : Vit. A, 150,000 UI; Vit. B1, 10 mg;; Vit. K3, 21mg ; Vit. E, 100 mg; Vit. B6, 15mg; Vit. B2, 40mg; Pantothenic acid, 100 mg; Niacin, 200 mg; Vit. B12, 0.1mg; Biotin, 0.5mg; Choline chloride, 5000 mg; Mn, 600 mg;Folic acid, 10 mg; Cu, 50 mg; Co, 2 mg; Fe, 0.3mg; Zn, 450mg and.Se, 1mg.

Calculated according to NRC (1980).

Antioxidants:

1- Vitamin E (α- tocopherol acetate from natural source; each gram contains a minimum of 889 mg of D-αtocopherolacetate, equivalent to 1100 IU), produced by Hoffmann-LaRoche).

2- Organic selenium was SelPlex™ in the form of selenium yeast (Alltech Inc.) contained 1000 ppm organic selenium and produced by the fermentation of yeast (*Saccharomyces cerevisiae*) in a high organic selenium medium.

3- Zinc-Methionine complex was obtained from Ibex company , Egypt and the purity of Zinc-Methionine complex was 98%.

Rabbits were fed *ad libitum* throughout the experimental period (8weeks)and daily feed consumption was recorded. All rabbits were weighed individually at the beginning of the experiment and biweekly thereafter. Average daily weight gain and feed conversion were calculated.

Blood samples were collected during sacrificing rabbits at of the experiment in dry tubes. Samples of serum were obtained and stored at −20°C to be used for biochemical analysis. All blood serum (serum total protein, albumin; while globulin was obtained by subtracting the concentration of albumin from that of total protein; urea, creatinine, total glucose, cholesterol, aspartate amino transferase (AST), alanine amino transferase (ALT), and Alkaline phosphatases (ALP) were estimated by commercial kits.

Total antioxidant capacity (TAC), glutathione peroxidase (GSH-Px) and malondialdehyde (MDA) in serum were also measured using commercial kits obtained from Biodiagnostic, Giza, Egypt

Digestibility trial:

A digestibility trail was estimate to determine the digestibility coefficient of the six diets used. Three rabbits from each group housed individually in metabolic cages separation of faeces and urine. Digestibility trial lasted 15 days (10 days as a preliminary period and 5 days as collection period). Samples from both feed offered and faeces of each rabbit were taken daily during the collection period for chemical analysis that carried out according to AOAC (1995). The total digestible nutrients (TDN) and digestible crude protein (DCP) were calculated according to by Perez *et al*., (1995).

Statistical analysis:

The data obtained in this study were analyzed by using the general linear GLM procedure of SAS program (SAS, Institute, Inc., 2002). Significant differences among means were detected by the method of Duncan (1955).

RESULTS AND DISCUSSION

The concentration of cadmium in different types of water is present in Table (2). There were differences among the water types in the cadmium concentration, where W3 recorded the highest concentration followed by W2, while W1 had the lowest concentrations. The concentration of Cd in W3 was higher than the normal level of cadmium recommended in irrigation water being0.01 mg/l for Cd (FAO, 1976 and WHO, 1993). Zein *et al*. (2002a,b) found that heavy metals content were higher in drainage water than Nile water.

Data in Table (2) showed the contents of cadmium in clay soil and berseem as affected by their contents in water. There was significant differences on cadmium contents in samples of berseem and soil from the different locations, which reflects similar trend to their contents in water. Soil and berseem samples irrigated with W3 showed the highest cadmium content followed by those irrigated with W2, while soil and berseem irrigated with W1 had the lowest contents. Similar these results agree with Rusan *et al.* (2006) they reported that plant Cu, Pb, Mn and Cd increased with waste water irrigation. Heavy metals such as Cu, Pb and Cd are potential bioaccumulative toxicants for the dairy production system as soils tend to act as long term sinks for these metals (Alloway, 1995) via sorption onto metal oxides, particularly manganese and iron oxides (Brown and Parks, 2001). Abd El-Hady (2007) reported that much higher Mn, Cu, Ni, Pb and Cd in plant grown in drainage water irrigated lands compared to plant grown in Nile irrigated lands. The concentration of Cd in Berseem samples irrigated with W3 were higher than the maximum tolerable level of this element by rabbits being 0.5 ppm (NRC, 1980). Dheri *et al.* (2007) who found that sewage water contain high amount of cadmium. Therefore, it is possible that cadmium had been accumulated in the soil from which the forages were harvested. Due to high levels of cadmium in sewage water compare to that in canal water, it is expected that forages irrigated with canal water would have the lowest cadmium level and those irrigated with sewage water would have the highest cadmium level. Zein *et al*. (2002a) reported that the contents of heavy metals in wheat straw were greater when poor water quality was used for irrigation than that of the mixed or good water quality.

Table 2. Cadmium concentration in different type of water, clay soil and berseem were collected from the studied areas

Type	Cadmium concentration			SEM	p-value
	W1	W2	W3		
Water, (ppm/l)	0.003^{c}	0.010^{b}	0.162^{a}	0.025	0.0001
clay soil, (ppm on DM basis)	0.10^{b}	0.18^{b}	0.42^{a}	0.031	0.003
berseem, (ppm on DM basis)	0.20^{c}	0.41^{b}	0.96^{a}	0.073	0.0001

SEM = Standard error of means. W1: Nile water (Abou-Omar), W2: mixed Nile and polluted drainage water (El-Bana) and W3: polluted drainage water (KafrDokhmeis).

Growth parameters:

Average live body weight, daily gain, feed consumption , FCR, relative growth rate and the growth performance index (PI) of growing rabbits give contaminated diets with cadmium during different period of the experimental period are shown in Table (3). There were differences in average live body weight, daily gain, feed consumption, FCR and relative growth rate among growing rabbits in the experimental groups were not significant during the first interval (5-9 weeks of age). However, average live body weight, daily gain, feed consumption and FCR during the intervals from 9 to 13 weeks of age and the overall mean of average live body weight, daily gain, feed intake , FCR and PI (%) from 5 to 13 weeks of age were significantly lower in rabbits exposed to Cd (T2) than those fed the other groups. Average live body weight, daily gain, feed consumption and FCR of rabbits in group fed contaminated diet with Cd decreased by 27.63, 38.54, 14.39 and 39.34% compared with the control group (T1), respectively. These results revealed an accumulative effect of the diets contaminated with Cd. The reduced weight gain of rabbits found in this study is agreement with (Horiguchi *et al*., 1996; Abd-Elgawad *et al.* (1999) and Ibrahim *et al.* (2000). So, the reduction in growth performance could have been due to the reduce in feed consumption , or due to the overall increase in degradation of proteins and lipids as a result of adverse effects of Cd (Erdogan *et al*., 2005). However, vitamin E, Se or Zn either alone or in combination and supplies, the growth performance became significantly higher ($p < 0.005$) than in rabbits fed diet contaminated with cadmium. These results similar with results reported by Messaoudi *et al.* (2009), who found that Se increased the body weight of Wistar rats fed diet contaminated with cadmium. Also, Layachi and Kechrid (2012) found that the supplementation of vit. E and/or vit. C to animals diets contaminated with cadmium improved body weight.

Table 3. Growth performance traits of APRI rabbits fed diets containing cadmium supplemented with vit. E, Se and Zn from 5 to 13 wks of age.

Traits	Experimental diets*						SEM	P-value
	T1	T2	T3	T4	T5	T6		
No of rabbits at 5 wk	20	20	20	20	20	20	--	--
Final number at 13 wk	19	17	18	18	18	19	--	--
Initial body weight (g)	650	648	648.3	653.0	648.6	650.0	5.30	1.00
Final body weight (g)	2280^{a}	1650^{c}	2000^{b}	1970^{b}	1997^{b}	2100^{b}	17.11	0.0001
Daily weight gain (g):								
5-9 weeks	27.32	24.00	26.36	26.26	26.12	26.76	0.13	0.063
9-13weeks	30.89^{a}	11.78^{d}	21.90^{bc}	20.77^{c}	22.02^{bc}	25.05^{b}	0.660	0.0001
5-13 weeks	29.11^{a}	17.89^{d}	24.14^{bc}	23.52^{c}	24.07^{bc}	25.89^{b}	0.311	0.0001
Feed intake (g/d):								
5-9 weeks	81.00	79.95	80.96	80.67	80.53	80.93	0.281	.925
9-13weeks	132.35^{a}	100.67^{c}	126.07^{b}	125.46^{b}	126.11^{b}	128.21^{b}	0.361	0.0001
5-13 weeks	106.67^{a}	91.32^{c}	103.52^{b}	103.07^{b}	103.32^{b}	104.57^{b}	1.234	0.0001
Feed conversion ratio :								
5-9 weeks	2.96	3.33	3.07	3.07	3.09	3.03	0.037	0.078
9-13weeks	4.29^{c}	8.54^{a}	5.79^{b}	6.05^{b}	5.73^{b}	5.20^{bc}	0.349	0.0001
5-13 weeks	3.66^{c}	5.10^{a}	4.30^{b}	4.39^{b}	4.29^{b}	4.05^{b}	0.112	0.0001
Relative growth rate :								
5-9 weeks	74.11	68.28	77.53	72.01	72.08	73.24	0.766	0.362
9-13weeks	46.78^{a}	22.22^{d}	36.17^{bc}	34.63^{c}	36.54^{bc}	40.00^{b}	1.853	0.0001
5-13 weeks	111.25^{a}	87.20^{c}	101.98^{b}	100.37^{b}	101.92^{b}	105.49^{b}	1.845	0.0001
Performance index (%)	62.25^{a}	32.35^{c}	46.73^{b}	45.01^{b}	46.52^{b}	52.11^{b}	2.305	0.0001
Mortality (%)	5^{c}	15^{a}	10^{b}	10^{b}	10^{b}	5^{c}	0.022	0.002

T1 (control): 0.28 ppm Cd , T2: Cd-diet, T3: Cd-diet plus vit E , T4: Cd-diet plus Se, T5: Cd-diet plus Zn and T6: Cd-dietplusvit. E plus Se plus Zn :SEM = Standard error of means,

Mortality rate:

Mortality rate of contaminated groups with the high levels of Cd (T2) was higher than those fed the control and the other treatments. Similar results obtained by Swaileh *et al.* (2002) they found that cadmium proved to cause the highest rate of mortality. Treatments with vitamin E, Se, Zn alone and their combination decreased mortality rate.

Digestibility coefficients:

Digestibility coefficients of nutrients in different experimental groups are shown in Table (4). The present results show that digestibility coefficients of CP, EE and NFE were significantly decreased in group fed diet contaminated with Cd as compared to the control group. The corresponding reduction in nutrient digestibility coefficients with increasing Cd contamination may be related to the toxic effect of high dose on microorganisms in gastrointestinal tract (GIT) of rabbits, especially in the caecum, which in turn causes an adverse effect on caecal fermentation. Regarding the nutritive values, we notice that TDN was affected significantly ($P<0.05$) by the highest dose of contamination with Cd (0.96 mg, T2). This was associated with the significant reduction in digestibility coefficients of CF in this treatment compared to the other treatments. However, nutritive value such as DCP was significantly lower in T2 than the other groups. Such trends were attributed to CP digestion in the experimental treatments. Similar results were obtained by Bersenyi *et al.* (1999) who found that Cd intake resulted in a considerable reduce in nutrients digestibility. Ibrahim *et al.* (2000) found that Cd contamination decreased digestibility coefficients by growing rabbit. Fekete *et al*. (2001) reported that both beet and potato root of high cadmium and Pb contents had the significantly lowest digestibility of nutrients. However, groups with vit. E, Se, Zn alone and a combination improved digestibility coefficients by growing rabbits fed diet contaminated with cadmium.

Table 4. Apparent digestibility for rabbits fed the experimental diets .

Parameters	Experimental diets*						SEM	p-value
	T1	T2	T3	T4	T5	T6		
Nutrients digestibility coefficients %:								
CP	74.83^{a}	65.41^{c}	73.60^{b}	73.00^{b}	73.45^{b}	74.90^{a}	0.801	0.0001
CF	24.5^{a}	21.60^{c}	23.10^{b}	24.0^{a}	23.65^{b}	24.10^{a}	0.247	0.0001
EE	81.20^{a}	74.55^{d}	79.20^{bc}	78.90^{c}	79.00^{c}	80.05^{b}	0.510	0.0001
NFE	73.42^{a}	68.17^{c}	70.52^{b}	71.48^{b}	70.96^{b}	71.30^{b}	0.173	0.0001
Nutritive values %:								
TDN	60.28^{a}	55.08^{c}	58.20^{b}	58.72^{b}	58.48^{b}	59.02^{b}	0.394	0.0001
DCP	13.00^{a}	11.36^{c}	12.77^{b}	12.67^{b}	12.75^{b}	13.00^{a}	0.139	0.0001

T1 (control): 0.28 ppm Cd , T2: Cd-diet, T3: Cd-diet plus vit E , T4: Cd-diet plus Se, T5: Cd-diet plus Zn and T6: Cd-dietplusvit. E plus Se plus Zn., TDN: totaldigestible nutrient , DCP: digestible crude protein.

Blood biochemical parameters:

Serum of animals exposed to contaminated diet showed significantly increased of serum AST, ALT , ALP, glucose, creatinine and urea levels compared with the control group (T1). In addition, the level of T. protein , albumin and cholesterol in serum were decreased ($p < 0.05$). While , supplementation of vit. E, Se or Zn alone or with Cd caused on increase in T. protein , albumin and globulin (Table 5). In addition, the activities of enzymes (AST, ALT and ALP) in addition to the levels of glucose, creatinine and urea were significantly reduced in rabbit groups fed diets with feed additives (vit. E, Se or Zn either alone or in combination). While, vit. E, Se and Zn combination showed more efficacy than vit. E, Se or Zn individually (Table 5). These results agree with Layachi and Kechrid (2012). Cadmium can reduce T. protein and albumin in serum of rabbit by changes in protein synthesis and/or metabolism and induce membrane damage (Dostal *et al*., 1989; Das Dasgupta, 2000 Yousuf, 2002 and Uyanik *et al.,* 2001). However, the enzymes of AST, ALT and ALP were increased, compared to the control group. It could be related to the hepatic damage resulting in increased releasing and leakage out of these enzymes from the liver cytosol into the blood stream which gives an indication on the hepatotoxic effect of this metal (Pari and Murugavel, 2005). The addition of vit.E, Se or Zn had prevented liver function from the adverse effects of cadmium as indicated by the significant restoration of serum total protein, glucose, albumin, ALT, AST, and ALP.

Table 5. Some biochemical constituents in blood of growing APRI rabbits fed diets containing cadmium supplemented with vit. E, Se and Zn at 13 wks of age.

Items	Experimental diets						SEM	p-value
	T1	T2	T3	T4	T5	T6		
T. protein (mg/dl)	6.53^{a}	5.45^{c}	5.93^{bc}	6.06^{ab}	5.81^{bc}	6.31^{ab}	0.099	0.006
Albumin (mg/dl)	3.78	3.15	3.26	3.32	3.49	3.43	0.080	0.304
Globulin (mg/dl)	2.75^{a}	2.30^{b}	2.66^{ab}	2.73^{a}	2.32^{b}	2.88^{a}	0.066	0.015
Cholesterol (mg/dl)	54.33^{b}	65.03^{a}	56.66^{b}	56.16^{b}	55.16^{b}	55.16^{b}	1.072	0.010
AST (IU/L)	51.63^{b}	77.05^{a}	60.06^{b}	60.91^{b}	57.33^{b}	52.99^{b}	2.320	0.002
ALT (IU/L)	14.16^{b}	18.97^{a}	16.02^{b}	14.45^{b}	14.76^{b}	14.78^{b}	0.467	0.002
ALP (IU/l)	50.16^{d}	73.26^{a}	58.58^{b}	58.13^{bc}	58.16^{bc}	53.60^{cd}	1.815	0.0001
Glucose (mg/dl)	77.06^{d}	130.50^{a}	96.43^{b}	87.83^{c}	90.06^{c}	80.86^{d}	4.307	0.0001
Creatinine (mg/dl)	0.89^{c}	1.85^{a}	1.18^{b}	1.13^{b}	1.27^{b}	1.00^{bc}	0.031	0.03
Urea (mg/dl)	14.06^{b}	27.93^{a}	13.96^{b}	12.50^{b}	15.06^{b}	13.93^{b}	0.885	0.025
Antioxidants status:								
TAC, nmol/ml	1.62^{a}	.983^{b}	1.42^{a}	1.54^{a}	1.46^{a}	1.43^{a}	0.057	0.003
GSH-PxU/g protein	1.44^{a}	.716^{c}	1.05^{b}	1.08^{b}	1.06^{b}	1.20^{b}	0.055	0.0001
MAD, nmol/ml	16.23^{b}	24.50^{a}	17.60^{b}	14.33^{b}	18.20^{b}	16.80^{b}	0.885	0.002

T1 (control): 0.28 ppm Cd T2: Cd-diet, T3: Cd-diet plus vitE , T4: Cd-diet plus Se, T5: Cd-diet plus Zn and T6: Cd-diet plus vit. E plus Se plus Zn. SEM = Standard error of means, TAC: Total antioxidant capacity, MAD: Malondialdehyde,

Cadmium chloride intoxicated rabbits also showed a high concentration of glucose. The high level in glucose is a joint result of heavy metal toxicity and is usually attacked to reduction of insulin releasing from Langerhans' islets (Dormer *et al.,*1973; Kechrid *et al.,* 2006) or with a block of glucose utilization by cells even in the presence of elevated levels of insulin (Sunderman *et al.,* 1976) or due to perturbation in glucagon secretion result in high glycogen breakdown and new supply of glucose production from protein sources (Massanyi *et al.,* 1995). However, there is an improvement of glucose level in blood for rabbits fed Cd supplemented with vit. E , Se or Zn alone or together. There are many possible explanations for the reduction in serum glucose. Addition of vitamin E, Se or Zn may improve insulin receptors in adipose tissue or muscle by enhancing membrane motility, secondary to increase glucose uptake by the diaphragm (Bierenbaum *et al.,* 1985).

Cadmium exposure produced a reduction in serum GSH-Px ,TAC while increase serum MAD compared with the control and the other groups (Table 5). Groups with vit. E, Se, Zn alone and a together improved these measurements. The reduction of GSH-Px and TAC level in animals exposed to cadmium may be as a result of oxidative stress, which has occurred of the adverse effects of cadmium. The reduction in antioxidant production due to the enhanced oxygen metabolites and the increased free radicals, which rised a reduce in the activity of the anti-oxidant defense system (Gstraunthaler *et al*., 1983). Many explanations have been suggested to show the reduction of glutathione concentration in the adverse effects of heavy metals. Firstly, glutathione may be oxidized, due to the interaction with the free radicals, induced by nickel. Therefore, glutathione concentration could be consumed during nickel detoxification (Manna *et al.,* 2008).. Secondly, the sulfhydryl group of cysteine moiety of glutathione has a high affinity of metals, forming thermo-dynamically stable mercaptide complexes with many metals. These complexes are inefficient which can be excreted via the bile (Aposhian, 1989). In addition, the reduction of GSH-Px activity in animals exposed to cadmium proposes that either there is an interaction between the accumulated free radicals and the active amino acids of this enzymes (Das *et al*., 2001) or there is a direct binding of the metal to the active sites of the enzyme (Misra *et al*., 1990). Supplementation of vit. E , Se or Zn alone or in combination caused significant improved glutathione and TAC levels while, MAD decreased when compared with T2. In the present study, glutathione peroxidase activity showed significant decrease in group exposed to cadmium. The decreased activity of the GSH-Px may result from a direct depletion of selenium by Cd or from insufficient incorporation of sulphur containing amino acids into GSH-Px because of competition with the Cd –metallothioniens synthesis (Baradaran,*et al.,* 2013). Moreover, Shaikh, *et al.* (1999) reported that, exposed to cadmium decreases the activities of many enzymes by inhibiting the protein synthesis or by binding to their sulfhydryl groups .

GSH-Px activity showed significant increase by cadmium with selenium-exposed rabbits. Similar observations were reported by Ognjanovic *et al.* (2008) who mentioned that treatment with selenium protect the adverse effects of cadmium on the activity of GSH-Px and prevents lipid peroxidation and oxidative damage induced by cadmium. This preventation involves the ability of selenium to improve the cadmium distribution in tissues and to stimulate bound of Cd-Se compounds to proteins which are similar to metallothioneins. Also, it has been suggested that Se addition elevates the activities of Sedependent antioxidant enzymes like glutathione peroxidase that could be due to elevated combination of selenocysteine which is substantial for their activities (Shaikh *et al*., 1999).

In this respect, zinc exhibits antioxidative properties during exposure to cadmium through its ability to interact with various elements such as iron and copper reducing their content in tissues and diminishing the oxidative processes (Jemai, *et al.,* 2007). This trace element protactive reactive oxygen species production and is incorporated in cell membrane stabilization, superoxide dismutase (Cu/Zn SOD) and structure metallothionin (Mt) synthesis (Tandon, *et al.,* 2001).

Vitamin E addition enough to prevent the organism from toxic agent and free radical damage is a time consuming process. It is concluded that vit. E is an major compound of the kidney for preventation of this tissue against peroxidative damage (Champe and Harvey, 1987). Hanafy and Soltan (2004) reported the prevent effect of vit. E on some heavy meatals such as Hg, cobalt, Pb, or nitrate induced rats. They found that the supplementation of vit. E and examined heavy metals can decrease the histological alteration and decrease creatinine and urea level in serum. Turguta *et al.* (2006) found that the supplementation of vit. E combined with aluminum (Al) lead to recovery of GSH and MDA concentration in mice supplemented with Al. That is, a chronic high dose of Al can lead to tissue oxidative injury, and vit. E can protecting the adverse effects of Al^{+3} ions. So, the observed normalization of glutathione peroxidase concentration, TAC and MAD following vit. E, Se or Zn supplement could be because these additives (antioxidants) played an action in diminishing the levels and accumulation of reactive oxygen species (ROS). While, vit. E supplemented with Se plus Zn suggested more effective as compared to individual alone.

CONCLUSION

Based on the results of the experiment, it is concluded that using polluted drainage water alone or mixed with Nile water in irrigation of agriculture land led to increasing the accumulation of cadmium in berseem causing possible hazardous effect in animal and human health. Contaminating of growing rabbit diets with cadmium revealed adverse effect on their productive performance, and mortality rate. Vitamin E, Se , Zn alone or combination have protective effect on Cd-induced oxidative stress. This study suggests that supplementation of vitamin E, Se , Zn alone or in combination may be a useful protective agent against the effect of the studied cadmium due to its antioxidant properties.

REFERENCES

Abd-Elgawad, E.M.; E.A. Mabrouk and M.A.M. Kandile (1999).Effect of lead and cadmium on reproductive performance of male rabbits. Assiut Vet. Med. J., 41: 230.

Abd El-Hady, B. .A. 2007. Compare the effect of polluted and river Nile irrigation water on contents of heavy metals of some soils and plants. Research Journal of Agriculture and Biological Sciences, 3: 287.

Abdo K.S.A. and Abdulla, H. (2013).Effect of cadmium in drinking water on growth, some haematological and biochemical parameters of chicken. European Journal of Experimental Biology 3, 287–291.

Al-Othman A. M., Al-Numair K. S., El-Desoky, G. E., Yusuf, K., Al Othman, Z. A., Aboul-Soud, M. A. M., (2011). Protection of -tocopherol and selenium against acute effects of malathion on liver and kidney of rats. African J.Pharm Pharmacol. 5: 1054-1062.

Alloway, B. J. (1995). Soil processes and the behavior of metals. Heavy Metals in Soils.2nd ed. B.J. Alloway, ed. Kluwer Academic Publ., Dordrecht, The Netherlands.P. 11.

Agarwal, R., Goel, S. K., Chandra, R., Behari, J. R. (2010). Role of vitamin E in preventing acute mercury toxicity in rat. Environ Toxicol Phar. 29: 70-78.

AOAC, (1995). Official Methods of Analysis.16th Ed. Association of Official Analytical Chemists. Washington, DC.

Aposhian, H. V.(1989). Biochemical toxicology of arsenic. Rev. Biochem. Toxicol. 10:265-299.

Aslam, F., Khan, A., Khan, M. Z., Sharaf, S., Gul, S.T., Saleemi, M.K.(2010).Toxico-pathological changes induced by cypermethrin in broiler chicks: Their attenuation with Vitamin E and selenium. Exp Toxicol Pathol. 62: 441-450.

Baradaran A., Nasri, H., Nematbakhsh, M.,Rafieian–Kopaei, M. (2013).Antioxidant activity and preventive effect of aqueous leaf extract of Aloe Vera on gentamicin induced nephrotoxicity in male wistar rats. Clin. Ter. 165 (1),7.

Bersenyi, A.,Fekete,S.,Hullar; I., Kadar,I., Szilagyi,M., Glavits,R., Kulcsar,M.,Mezes,M., Zoldag,L. (1999). Study of the soil-plant (carrot)-animal cycle of nutritive and hazardous minerals in a rabbit model. Acta. Vet. Hung., 47:181.

Bharathi, E., Jagadeesan, G., Manivasagam, T., (2012). Influence of s-allyl cysteine against mercuric chloride induced nephrotoxicity in albino rats. J Chem Pharm Res., 4: 1470-1474.

Bierenbaum, M. L., Noonan, F. J., Machlin, L. J., Machlin, S., Stier, A., Watson, P.B., Naso, A.M., Fleischman, A.I.,(1985). The effect of supplemental vitamin E on serum parameters in diabetics, post coronary and normal subjects. Nutr. Rep. Int. 31(6):1171-1180.

Brown, G.E., Parks, G.A., (2001). Sorption of trace elements on mineral surfaces: Modern perspectives from spectroscopic studies, and comments on sorption in the marine environment. Int. Geol. Rev., 43: 963.

Champe, P.C., Harvey, R.A., (1987). Vitamin E. In: Barnes, D., Robinson, S., Hoeltze, L.E., Baldwin, T.J.B. (Eds.), Lippincott's Illustrated Review Biochemistry. Lippincott Com., Philadelphia, pp. 311–331 (Chapter 27: Vitamins).

Chen, L., Liu, L., Huang, S.,(2008). Cadmium activates the mitogen-activated protein kinase (MAPK) pathway via induction of reactive oxygen species and inhibition of protein phosphatases 2A and 5. Journal of Free Radical Biology and Medicine 45, 1035–1044.

Cottenie,Verloo,M.,Kiekenes,L.,Velghe,G.,Camerlyuck,R. ,(1982).Chemi-cal Analytical of Plants and Soil. Lab. Anal. And Agrochem.State Univ. Gent. Belgium, Chapters 2, 3, pp. 14.

Das, K. K., Dasgupta, S.,(2000). Effect of nickel on testicular nucleic acid concentrations of rats on protein restriction. Biol. Trace. Elem. Res. 73(2):175-180.

Das, K. K., Das, S. N., Das, G. S.,(2001). The influence of ascorbic acid on nickel-induced hepatic lipid peroxidation in rats. J. Basic Clin. Physiol. Pharmacol. 12(3):187-195.

De Blas, J. C. and Mateos, G. G. (1998). Feed formulation. In: The Nutrition of the Rabbit. (De Blas and J. Wiseman Eds) Wallingford, CABI Publ., UK. Chapter 13, 241-254.

Dheri, G.S., Brar,M.S.,Malhi,S.S. (2007). Heavy-metal concentration of sewage-contaminated water and its impact on underground water, soil, and crop plants in alluvial soils of northwestern India. Commun. Soil. Sci. Plant Anal., 38:1353-1370.

Diplock, A. T., Watkins, W. J., Heurson, M., (1986).Selenium and heavy metals. Ann Clin Res. 18: 55-60.

Dormer, R. L., Kerbey, A. L., McPherson, M., Manley, S., Ashcroft, S. H., Schofield, J. G., Randle, P. J.(1973). The effect of nickel on secretory systems: Studies on the release of amylase, insulin and growth hormone. Biochemistry 140:135-140.

Dostal, L. A., Hopfer, S. M., Lin, S. M., Sunderman, F. W. (1989). Effects of nickel chloride on lactating rats and their suckling pups, and the transfer of nickel through rat milk.Toxicol. Appl. Pharmacol. 101(2):220-231.

Duncan, D.B. (1955). Multiple range and multiple F. test. Biometric., 11: 1-42.

El-Deek, A. A., El-Sayed, M. A., Kandeel, K. M. Mahmoud, M. M.,(2010).Effect of different levels of cadmium and selenium on 1-Performance of broiler chickens. Egyptian Poultry Science Journal 30, 699–712.

El-Demerdash, F. M., (2004). Antioxidant effect of vitamin E and selenium on lipid peroxidation, enzyme activities and biochemical parameters in rats exposed to aluminium. J Trace Elem Med Bio. 18: 113-121.

Erdogan, Z., Erdogan, S., Celik, S. and Unlu, A. (2005).Effects of ascorbic acid on cadmium-induced oxidative stress and performance of broilers. Biological Trace Element Research 104, 19–32.

FAO,(1976).Soil survey investigations for irrigation. Soil Bull. 42, Rome. Feachem, R.G., D.J. Bradley, H. Garelick and D. D. Mara. 1983. Sanitation and disease-health aspects of excreta and wastewater management. John Wiley & Sons, Chicester, England.

Fekete, S., Bersenyi, A., Kadar,I., Glavits,R., Koncz, J.,Zoldag,L. (2001).Study of soil-plant (potato and beet root)-animal cycle of nutritive and hazardous minerals in a rabbit model. Acta. Vet. Hung., 49: 301.

Gail, L., Baker, C. H., Baker, D. H.,(1982). Tolerance of the chick to excess dietary cadmium as influenced by dietary cysteine and by experimental infection with *Eimeriaa cervulina*. Journal of Animal Science 54, 983–988.

Gstraunthaler, G., Pfaller, W., Kotanko, P.,(1983). Glutathione depletion and in vitro lipid peroxidation in mercury or malate induced acute renal failure. Biochem. Pharmacol. 32:2969-2972.

Hanafy, S., Soltan, M.E., (2004).Effects of vitamin E pre treatment on subacute toxicity of mixture of Co, Pb, and Hg nitrate induced nephrotoxicity in rats. Environ. Toxicol. Pharmacol. 17, 159–167.

Horignchi, H.; Sato, M.; Konno,N. and Fukushima, M. (1996). Long- term cadmium exposure induces anemia in rats through hypo-induction of erythropoietin in the kidneys. Arch. Toxicol., 71: 11-19.

International Agency for Research on Cancer (IARC), (1993).Cadmium and cadmium compounds. In Beryllium, cadmium, mercury and exposures in the glass manufacturing industry. IARC monographs on the evaluation of carcinogenic risk of chemicals to humans (ed. Sine nomine), 58, pp. 119–239.IARC,Lyon, France.

Ibrahim, S.A.M.,Osfor,M.M.H.,El-Mallah,G.M., (2000).Garlic and panaxginseng as dietary supplements against the contamination with mercuric chloride in New Zealand rabbits. Egyptian J. Rabbit Sci., 10: 207.

Jemai, H., Messaoudi, I., Chaouch, A., Kerkeni, A., (2007). Protective effect of zinc supplementation on blood antioxidant defense system in rats exposed to cadmium. J Trace Elem Med Biol., 21:269-73.

Kaneko, J.J.,(1989).Clinical biochemistry of domestic animals. 4th ed. San Diego: Academic Press; 1989.

Kechrid, Z., Dahdouh, F., Djabar, R. M., Bouzerna, N.,(2006).Combined effect of water contamination with cobalt and nickel on metabolism of albino (Wistar) rats. Environ. Health Sci. Eng. 3(1):65-69.

Kour, N., Rahman, S., Azmi, S., Hussain, K., Raghuwanshi, P.,Dutta, S.,(2014).Effect of cadmium toxicity on general growth performance parameters in Wistar rats. Indian Journal of Veterinary and Animal Sciences Research 43, 288–297.

Layachi, N. and Kechrid,Z. (2012). Combined protective effect of vitamins C and E on cadmium induced oxidative liver injury in rats. African Journal of Biotechnology Vol. 11(93), pp. 16013-16020

Manna, P., Sinha, M., Sill, P. C.,(2008). Arsenic-induced oxidative myocardial injury: protective role of arjunolic acid. Arch. Toxicol. 82:137-149.

Massanyi, P.,Toman, R., Valent, M., Cupka, P.,(1995).Evaluation of selected parameters of a metabolic profile and levels of cadmium in reproductive organs of rabbits after an experimental administration. Acta. Physiologica Hung. 83:267-273.

Messaoudi, I., El-Heni, J., Hammouda, F., Saïd, K. and Kerkeni, A., (2009). Protective Effects of Selenium, Zinc, or Their Combination on Cadmium-Induced Oxidative Stress in Rat Kidney. Biological Trace Elements Research, 130,152-161.

Misra, M., Rodriguez, R. E., Kasprzak, K. S.,(1990) . Nickel induced lipid peroxidation in the rat: correlation with nickel effect on antioxidant dense systems. Toxicology 41:601-611.

Morakinyo, A. O., Iranloye, B. O., Oludare, G. O., Oyedele, O. J., Ayeni, O. O., (2012).Mercury chloride-induced glucose intolerance in rats: Role of oxidative stress. Br J Pharmacol Toxicol,; 3: 7-12.

NRC,(1980).Mineral Tolerance of Domstic Animals .National Academy Press. Washington, D.C.

Ognjanovic, B. I., Markovic, S. D., Pavlovic, S. Z., Zikic, R. V., Stajn, A. S., Saicic, Z. S., (2008). Effect of chronic cadmium exposure on antioxidant defense system in some tissues of rats: Protective effect of Selenium. Physiol Res., 57: 403-411.

Olgun, O.,(2015). The effect of dietary cadmium supplementation on performance, egg quality, tibia biomechanical properties, and egg shell and bone mineralization in laying quails. Animal 9, 1298–1303.

Pascoe, G. A., Olafsdottir, K., Reed, D. J. (1987). Vitamin E protection against chemical-induced cell injury. I. Maintenance of cellular protein thiols as a cytoprotective mechanism Arch. Biochem .Biophys., 256 , pp. 150-158

Pari, L. and Murugavel, P.,(2005). Role of diallyl tetrasulfide in ameliorating the cadmium induced biochemical changes in rats. Environ. Toxicol. Pharmacol. 20:493-500.

Perez, J. M., Lbas, F., Gidenne, T., Martens, L., Xiccato, G., Perigi-Bini, R.., Dallo-Zotte, A., Cossu, M. E., Carazzolo, A., Villamide, M. J.,Carabaño, R.,Fraga, M. J., Ramos, M. A., Cervera, C., Blas, E., Fernandez-Carmona, J.,Falcão, E.Cunha,Cmnha, M. L. Bengala Freire, J.,(1995). European reference method for in vivo determination of diet digestibility in rabbits. World Rabbit Sci., 3: 41-43.

Rusan, M.J.M., Hinnawi,S.,Rousan,L., (2006). Long term effect of waste water irrigation of forage crops on soil and plant quality parameters. Desalination, 215: 143.

Said, R. S., Badr, A. M., Nada, A.S., El-Demerdash, E., (2014). Sodium selenite treatment restores long-lasting ovarian damage induced by irradiation in rats: Impact on oxidative stress and apoptosis. Reprod Toxicol. 43: 85-93.

Sanz, N., Diez-Fernandez, C., Andres, D., Cascales, M., (2002). Hepatotoxicity and aging: endogenous antioxidant systems in hepatocytes from 2-, 6-, 12-, 18- and 30- month-old rats following a necrogenic dose of thio-acetamide. Biochim Biophys Acta., 1587: 12-20.

SAS Institute, (2002).User installation guide for the SAS® system; version 9 for Microsoft® Windows®.Cary.

Shaikh, Z.A., Vu,T.T., Zaman, K.,(1999).Oxidative stress as a mechanism of chronic cadmium-induced hepatotoxicity and renal toxicity and protection by antioxidants.Toxicol. Appl. Pharmacol., 154(3): 256-263.

Stohs, S. J., Bagchi, D., (1995).Oxidative mechanisms in the toxicity of metal ions. Free Radic Biol Med., 18: 321-336.

Sunderman, Jr., Kasprzak, K. S., Horak, E., Gitltz, P., Onkelinx, C.,(1976).Effect of tri-ethylene tetra amine upon the metabolism and toxicity of $^{63}NiCl_2$in rats. Toxicol. Appl. Pharmacol. 38:177-188.

Swaileh, K., Hussein,R., Halaweh,N., (2002).Metal accumulation from contaminated food and its effect on growth of juvenile lands nails *Helixen gaddensis*. J. Environ. Sci. Health B., 37: 151.

Tandon, S.K., Singh, S. ,Prasad, S., (2001). Mathur Hepatic and renal metallothionein induction by an oral equimolar dose of zinc, cadmium or mercury in mice Food Chem. Toxicol., 40 , pp. 571-577

Tsuji, N., Hirayanagi, N.M., Okada, H., Miyasaka, K., Hirata, M.H., ZenK. K., (2002).Enhancement of tolerance to heavy metals and oxidative stress in Dunaliellatertiolecta by Zn-induced phytochelation synthesis Biochemical and Biophysical Research Communication, 293 , pp. 653-659.

Turguta, G.,Enlib, Y., Kaptanoğlub, B., Turguta, S., Genç, O., (2006).Changes in the levels of MDA and GSH in mice serum, liver and spleen after aluminum administration. Eastern Journal of Medicine: 11:7-12.

Uyanik, F., Eren, M., Atasever, A., Tuncoku, G., Kolsuz, A. H.,(2001). Changes in some biochemical parameters and organs of broilers exposed to cadmium and effect of Zinc on cadmium induced alteration. Israel. Vet. Med. 56:128-134.

Whelton, B. D., Peterson, D. P., Moretti, E. S., Mauser, R. W., Bhattacharyya, M.,(1997a). Kidney changes in multiparous, nulliparous and ovary ectomized mice fed either a nutrient-sufficient or – deficient diet containing cadmium. Toxicology119, 123–140.

Whelton, B. D., Peterson, D. P., Moretti, E. S., Mauser, R. W., Bhattacharyya, M.,(1997b).Hepatic levels of cadmium, zinc and copper in multiparous, nulliparous and ovari ectomized mice fed either a nutrient-sufficient or – deficient diet containing cadmium. Toxicology 119, 141–153.

WHO,(1993).World Health Organization. Guidelines for Drinking-water Quality. Volume 1: Recommendations, 2nd ed. World Health Organization, Geneva, Switzerland, p. 188.

Yousuf, M. B.,(2002). Effect of high dietary intake of nickel in the west African dwarf goat. Ghana. J. Agric. Sci. 35:147-151.

Zein, F. I., Omar ,E. M., Abd- Allah M. A. A., El-Yammani, M.S.,(2002a). Influence of irrigation water quality on heavy metals content of soil, water table and some crops at the Northern Nile Delta. Egypt. J. Soil Sci., 42: 739.

Zein, F.I., El-Yammani,M.S., El-Leithy,A.A., Moustafa, A.T.A., (2002b). Effect of polluted irrigation water on some crops and their contents of heavy metals. 2- Sugar beet. Egypt. J. Soil Sci., 42: 307.

التأثيرات الوقائية لأضافة فيتامين هـ - الزنك والسيلنيوم على اداء النمو وبعض القياسات البيوكيميائية للأرانب النامية المعرضة الى الكادميوم

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اجريت الدراسة الحالية فى محافظة كفرالشيخ خلال موسم ٢٠١٦ لفحص تأثير استخدام ثلاثة انواع من المياة النوع الأول مياة النيل (ترعة ابو عمر) ، النوع الثانى عبارة عن خليط من مياة النيل ومياة الصرف الملوثة (ترعة البنا) أما النوع الثالث فكان مياة صرف ملوثة (كفر دخميس) وذلك فى رى الأراضى الزراعية ثم دراسة تراكم الكادميوم فى التربة والبرسيم الذى يزرع فيها .ثم تأثيرة بعد ذلك على اداء النمو للأرانب التى تتغذى على علائق ملوثة بالكادميوم بنفس المستوى الموجود فى البرسيم . تم استخدام بعض المواد كمضادات لسموم الكادميوم مثل بعض مضادات الأكسدة مثل فيتامين هـ - زنك و سيلنيوم على ١٢٠ أرنب نامى من سلالة " ابرى " . تم تقسيم الأرانب الى ٦ مجاميع متساوية المجموعة الأولى تغذت على عليقة اساسية تحتوى على ٠.١ مليجرام كادميوم/ كجم علف على اساس المادة الجافة و المجموعة الثانية تغذت الأرانب على عليقة ملوثة بالكادميوم بمستوى نهائى على ٠.٩٦ مليجرام كادميوم/ كجم علف ، المجموعة الثالثة تغذت الأرانب على العليقة الملوثة مع اضافة فيتامين هـ (١٥٠ مليجرام /كجم علف) ، المجموعة الرابعة تغذت الأرانب على عليقة ملوثة مع اضافة السيلنيوم (٠.٢ مليجرام /كجم علف)، المجموعة الخامسة تغذت الأرانب على عليقة ملوثة مع اضافة الزنك (١٠٠ مليجرام /كجم علف) اما المجموعة السادسة تغذت الأرانب على العليقة الملوثة مضاف اليها فيتامين هـ - سلينيوم وزنك معا . اظهرت النتائج ان النوع الثالث من المياة سجل بصورة معنوية اعلى تركيز من الكادميوم يلية النوع الثانى بينما كان النوع الأول اقل تركيزا. فى حين ان عينات البرسيم المنزرعة فى تربة تروى بمياة النوع الثالث كانت الأعلى معنويا فى محتوى الكادميوم يليها البرسيم المنزرع فى تربة تروى بمياة النوع الثانى بينما البرسيم المنزرع فى تربة تروى بمياة النوع الأول اقل محتوى . اظهرت الأرانب المعاملة بالكادميوم نقص معنوى فى متوسط اداء النمو ومعامل هضم العناصر الغذائية بينما اضافة فيتامين هـ - زنك و سيلنيوم منفردة او معا حسنت معنويا كل قياسات النمو . لوحظت بعض التغيرات فى كل قياسات الدم فى مجموعة الأرانب التى تتناول عليقة ملوثة بالكادميوم فقط بينما كان لاضافة فيتامين هـ - زنك و سيلنيوم منفردة او معا الى العلائق الملوثة تأثير ايجابى ومعنوى على قياسات الدم . علاوة على ذلك نجد ان اضافة فيتامين هـ - زنك و سيلنيوم معا اظهرت كفاءة اكثر بالمقارنة بهذة الأضافات منفردة.