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Withdrawal Of Cadmium Residues From Egg And Tissues Of Intoxicated Balady Hens

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ABSTRACT

One hundred and fifty Balady hens were divided into five equal groups, each of thirty hens. The first group was kept as control, second and third group supplemented with 10 and 20 ppm cadmium chloride in drinking water for 10 weeks respectively. Fourth and fifth group supplemented 10 and 20 ppm cadmium chloride in addition to intracrop intubation by 75-mg/kg b.w. / week Ca EDTA for 10 weeks respectively. Cadmium level was determined in egg, liver, blood, muscle and bone after, 2, 4, 6, 8 and 10 weeks post - administration. Cadmium level was decreased with administration time specially in groups supplemented with Ca EDTA. Eggs and muscles from hens administered cadmium chloride plus Ca EDTA require at least 3 months post- administration to be safe for human consumption. While liver and bone should not be consumed even after 3 months.

INTRODUCTION

Cadmium is one of the most dangerous industerial pollutants which contaminates virtually food stuffs and drinking water of poultry. The residual amount of cadmium in egg and muscle constitute is a serious source of intoxication for human being *(1)*. Rats fed on a diet containing different amounts of cadmium chloride voided cadmium in urine after 5 weeks post feeding and renal excretion increased after 12 weeks *(2)* . The same authers suggested that the kidneys appear to have some protective action against cadmium intoxication during the early stages of poisoning.The clinical signs of cadmium intoxication in chickens are impaired feed efficiency , decrease in body weight, decalcification of bone , hyberkeratosis of keratoid membrane of the gizzard and bleeding of muscosa of the small intestine . Feeding of laying hens on a diet containing 5 or 10 mg cadmium / kg of feed , did not affect egg weight, body weight , mortility , hatching or fertility of eggs but only egg shell quality was reduced by feeding on 10 mg cadmium /kg of feed *(3)* . Cadmium inhibits the growth in alerins fish and cadmium uptake by eggs was rapid and the saturation level reached within 24h and maintained until hatching *(4)*. Separation of cadmium by column chromatography revealed that most of hepatic cadmium was associated with chickens receiving Fe thiamin in the livers from iron deficient chickens *(5)*. There was a direct relationship between the concentration of cadmium in soil, food and drinking water and its concentration in target tissues *(6)*. Cadmium decreases eggs production and a fall in thier shell mass. Cadmium residues were detected in muscles, cannon bone (tibia) and feathers. The highest cadmium level was recorded in egg shell membrane and lowest concentration in the egg white *(7)*. Cadmium storage was greater in the kidney than in liver, which was greater than in the gills *(4)*.

This study aimed to detect the withdrawal rate of cadmium and its level in eggs and some body tissues (blood, liver, bone and skeletal muscle) of intoxicated hens.

MATERIAL AND METHODS

One hundred and fifty mature, clinically healthy Balady hens twenty two weeks old were used in this study. The hens were divided into five equal groups.. The first group was kept as control, 2-nd and 3nd groups administered cadmium chloride in drinking water at doses of 10 and 20 ppm respectively *(3)*. The 4th and 5th groups administered drinking water containing 10 and 20 ppm cad. chloride, respectively , in addition to intracrop intubation of 75 mg/kg b.wt/week. Ca EDTA (El Nasr Company) *(8)*. The administration of cadmium chloride lasted 10 successive weeks. Feed and water were provided ad libitum.

Five hens from each group were slaughtered every two week and at the end of experimental period. Samples from eggs, blood, livers, bone (femur) and skeletal muscles (breast muscles) were obtained from slaughtered hens .

Samples were stored at -20°C until analysis. Samples were weighted, dried at 100°C and ashed *(9)*. Cadmium residues were determined using A pye Unicam model S.P. 1900 Atomic Absorption spectrophotometer.

All data were subjected to statistical analysis *(10)*.

RESULTS

Table (1) showed cadmium levels in eggs of control and intoxicated groups of hens administrated cadmium or cadmium and Ca EDTA. Cadmium levels of control group ranged from 0.0026 ± 0.006 at the end of experimental period (10 weeks) to 0.002 ± 0.0006 ppm.

The levels cadmium in the second and third group were decreased at the end of experimental period.

The lowest levels of cadmium in 4th and 5th groups were 0.0583 ± 0.361 and 0.1620 ± 0.003 ppm respectively after 10 weeks of post administrated cadmium. The withdrawal rates were 68.37%, 64.56%, 81.80% and 63.90% for second, third, fourth and fifth groups respectively (Fig. 1).

Table (2) showed cadmium level in liver of control and those hens administered different doses of cadmium only and in group 4th & 5th which received Ca EDTA. The lowest levels of cadmium were at 10 weeks after stopping the experiments. Cadmium levels were 0.0030 ± 0.001 ; 2.0133 ± 0.090 ; 3.7333 ± 0.242 ; 0.6500 ± 0.070 and 1.6566 ± 0.328 ppm for first (control), second, third , fourth and fifth groups respectively.

The withdrawal rate for cadmium after ten weeks from stopping experiments was 80.48%, 83.21 %; 90.29% and 80.89% for second, third , fourth and fifth groups respectively (Fig. 1).

Table (3) showed cadmium level in blood of control and groups administered cadmium and cadmium plus Ca EDTA. The lowest cadmium levels were detected at 10 weeks of post administration; which were 0.257 ± 0.257 ; 0.3233 ± 0.010 ; 0.0196 ± 0.030 and 0.1647 ± 0.030ppm for second; third, fourth and fifth groups in comparison to 0.003 ± 0.001 ppm of the control (first group). The withdrawal rate of cadmium residue was illustrated in Fig.1.

Table (4) clarify cadmium levels in muscles of hens intoxicated with cadmium or cadmium with Ca EDTA in comparison to control group. At of stopping administration or treatment, a significant cadmium levels were detected in skeletal muscles of treated groups than control. Cadmium level began to decreased by time specially in groups administered cadmium plus Ca EDTA. Cadmium levels in groups administered cadmium plus Ca EDTA were 0.0246 ± 0.003 and 0.0360 ± 0.003 ppm at 10 weeks of post - administrated in comparison to 0.0010± 0.0006 of the control group. The excreted rate of cadmium from muscle of treated groups reached to 69.16% specially in groups treated by cadmium plus Ca EDTA (Fig. 1).

Table (5) showed cadmium levels in bone of hens administered cadmium or cadmium plus Ca EDTA in comparison to control group. After 10 weeks of administration, cadmium levels were 55.1033± 0.778 ; 81.4466 ± 1.112; 38.500 ± 0.558 and 44.7700 ± 0.226 ppm in 2nd ,3rd , 4th , 5th , groups respectively in comparison to 3.0733 ± 0.301 ppm of control group. Cadmium levels started to decrease by time specially in group treated by Ca EDTA. Cadmium levels at 10 weeks of post- administration were 35.2667 ± 0.881; 61.2686 ± 0.269 ; 27.0116 ± 1.033 and 31.0133 ± 0.36 ppm in 2nd ,3rd , 4th and 5th. groups respectively in comparison to 2.3500 ± 0.49 ppm of control group . The rate of excretion of cadmium from bone was illustrated in Fig.1.

Table (1): Cadmium levels (ppm, wet weight) in eggs of the first(control), second and third groups (intoxicated with cadmium chloride), fourth and fifth groups (administered Cad. and Ca EDTA) of hens (Mean ± S.E.).

Time of sampling (week)post-administration period (10 week)	G1 control	G2 10 ppm Cad.	G3 20 ppm Cad.	G4 10 ppm Cad + 75 mg/ kg B.wt. CaEDTA	G4 20 ppm Cad + 75 mg/ kg B.wt. CaEDTA
Zero	0.002±0.006	$0.8853±0.010^{F}$	$1.08567±0.070^{E}$	$0.3200±0.040^{F}$	$0.4490±0.040^{D}$
2nd	0.0026±0.006	$0.7163±0.020^{E}$	$0.9670±0.030^{D}$	$0.2333±0.005^{E}$	$0.3686±0.010^{C}$
4th	0.0026 ± 0.002	$0.5380±0.020^{D}$	$0.8290±0.020^{C}$	$0.2143±0.008^{D}$	$0.2593±0.008^{B}$
6th	0.0023±0.009	$0.4420±0.020^{C}$	$0.6316±0.010^{B}$	$0.1966±0.003^{C}$	$0.2466±0.01^{B}$
8th	0.0026±0.003	$0.3743±0.010^{B}$	$0.4570±0.010^{A}$	$0.0963±0.007^{B}$	$0.2200±0.009^{AB}$
10th	0.0023±0.000	$0.2800±0.009^{A}$	$0.36846±.005^{A}$	$0.0583±0.361^{A}$	$0.1620±0.030^{A}$
Withdrawal rate%		68.37	64.56	81.18	63.9

Significant at $p<0.05$

Table (2): Cadmium levels (ppm, wet weight) in liver of the first (control), second and third groups (intoxicated with cadmium chloride), fourth and fifth groups (administered Cad. and Ca EDTA) of hens (Mean ± S.E.).

Time of sampling (week)post-administration period (10 week)	G1 control	G2 10 ppm Cad.	G3 20 ppm Cad.	G4 10 ppm Cad + 75 mg/ kg B.wt. CaEDTA	G4 20 ppm Cad + 75 mg/ kg B.wt. CaEDTA
Zero	0.0050±0.0006	$10.3186±0.186^{F}$	$22.2400±0.153^{F}$	$6.6903±0.111^{F}$	$8.7233±0.010^{F}$
2nd	0.0030±0.0009	$8.5000±0.162^{E}$	$16.5633±0.512^{E}$	$5.2683±0.147^{E}$	$7.3000±0.189^{E}$
4th	0.0026±0.001	$6.6566±0.231^{D}$	$13.0300±0.369^{D}$	$3.7466±0.155^{D}$	$5.9023±0.113^{D}$
6th	0.0063±0.003	$4.2600±0.191^{C}$	$9.2730±0.169^{C}$	$2.4966±0.159^{C}$	$4.7266±0.101^{C}$
8th	0.0026±0.0009	$3.0166±0.130^{B}$	$5.9366±0.050^{B}$	$1.5833±0.317^{B}$	$2.7733±0.117^{B}$
10th	0.0030 ±0.0010	$2.0133±0.090^{A}$	$3.7333±0.242^{A}$	$0.6500±0.070^{A}$	$1.6566±0.328^{A}$
Withdrawal rate%		80.48	83.21	90.29	80.89

Significant at $p<0.05$

Table (3): Cadmium levels (ppm, wet weight) in blood of the first(control), second and third groups (intoxicated with cadmium chloride), fourth and fifth groups (administered Cad. and Ca EDTA) of hens (Mean ± S.E.).

Time of sampling (week)post-administration period (10 week)	G1 control	G2 10 ppm Cad.	G3 20 ppm Cad.	G4 10 ppm Cad + 75 mg/ kg B.wt. CaEDTA	G4 20 ppm Cad + 75 mg/ kg B.wt. CaEDTA
Zero	0.0046±0.003	$0.9816±0.004^{F}$	$2.2000±0.080^{F}$	$0.6466±0.009^{F}$	$0.9233±0.010^{F}$
2nd	0.0020±0.0005	$0.7666±0.009^{E}$	$1.2300±0.040^{E}$	$0.5220±0.020^{E}$	$0.7966±0.030^{E}$
4th	0.0046±0.0030	$0.6450±0.010^{D}$	$0.9323±0.040^{D}$	$0.4233±0.020^{D}$	$0.5900±0.006^{D}$
6th	0.0020±0.0006	$0.5723±0.010^{C}$	$0.7450±0.010^{C}$	$0.2660±0.009^{C}$	$0.3950±0.003^{C}$
8th	0.0016±0.0003	$0.4400±0.006^{B}$	$0.5313±0.010^{B}$	$0.1930±0.007^{B}$	$0.2900±0.010^{B}$
10th	0.0030±0.0006	$0.2570±0.004^{A}$	$0.3233±0.010^{A}$	$0.0196±0.03^{A}$	$0.1467±0.030^{A}$
Withdrawal rate%		73.82	85.30	96.95	82.17

Significant at $p<0.05$

Table (4): Cadmium levels (ppm, wet weight) in muscle of the first(control), second and third groups (intoxicated with cadmium chloride), fourth and fifth groups (administered Cad. and Ca EDTA) of hens (Mean ± S.E.).

Time of sampling (week)post-administration period (10 week)	G1 control	G2 10 ppm Cad.	G3 20 ppm Cad.	G4 10 ppm Cad + 75 mg/ kg B.wt. CaEDTA	G4 20 ppm Cad + 75 mg/ kg B.wt. CaEDTA
Zero	0.0066±0.003	$0.1136±0.003^{F}$	$0.2360±0.005^{F}$	$0.0800±0.006^{F}$	$0.1033±0.009^{F}$
2nd	0.0010±0.006	$0.1000±0.006^{E}$	$0.2103±0.006^{E}$	$0.7833±0.004^{E}$	$0.0816±0.007^{E}$
4th	0.006±0.0003	$0.0946±0.003^{D}$	$0.1960±0.004^{D}$	$0.0583±0.004^{D}$	$0.0766±0.004^{D}$
6th	0.0016±0.0003	$0.0783±0.002^{C}$	$0.1656±0.005^{C}$	$0.0433±0.003^{C}$	$0.0653±0.003^{C}$
8th	0.0010±0.0000	$0.0550±0.003^{B}$	$0.1216±0.007^{B}$	$0.0316±0.002^{B}$	$0.0466±0.003^{B}$
10th	0.0010±0.0006	$0.0450±0.006^{A}$	$0.0816±0.004^{A}$	$0.0246±0.003^{A}$	$0.0360±0.003^{A}$
Withdrawal rate%		60.41	65.39	69.16	65.13

Significant at $p<0.05$

Table (5): Cadmium levels (ppm, wet weight) in bone of the first(control), second and third groups (intoxicated with cadmium chloride), fourth and fifth groups (administered Cad. and Ca EDTA) of hens (Mean ± S.E.).

Time of sampling (week)post-administration period (10 week)	G1 control	G2 10 ppm Cad.	G3 20 ppm Cad.	G4 10 ppm Cad + 75 mg/ kg B.wt. CaEDTA	G4 20 ppm Cad + 75 mg/ kg B.wt. CaEDTA
Zero	3.0733±0.301	55.1033±0.778^{F}	81.4466±1.112^{F}	38.5000±0.558^{F}	44.7700±0.276^{F}
2nd	2.4833±0.080	48.2166±0.240^{E}	75.4233±0.351^{E}	35.1166±0.950^{E}	42.2533±0.257^{E}
4th	2.8496±0.880	45.4166±0.749^{D}	70.6923±0.474^{D}	32.8553±0.70^{D}	39.2500±0.625^{D}
6th	3.7466±0.660	43.2066±0.213^{C}	68.5443±0.458^{C}	30.3566±0.512^{C}	37.3303±0.09^{C}
8th	2.9500±0.831	38.5100±0.541^{B}	64.9066±0.332^{B}	258.8833±0.714^{B}	35.1500±1.011^{B}
10th	2.3500±0.491	35.2666±0.881^{A}	61.2686±0.269^{A}	27.0116±1.003^{A}	31.0133±0.360^{A}
Withdrawal rate%		35.99	24.80	29.80	30.70

Significant at $p<0.05$

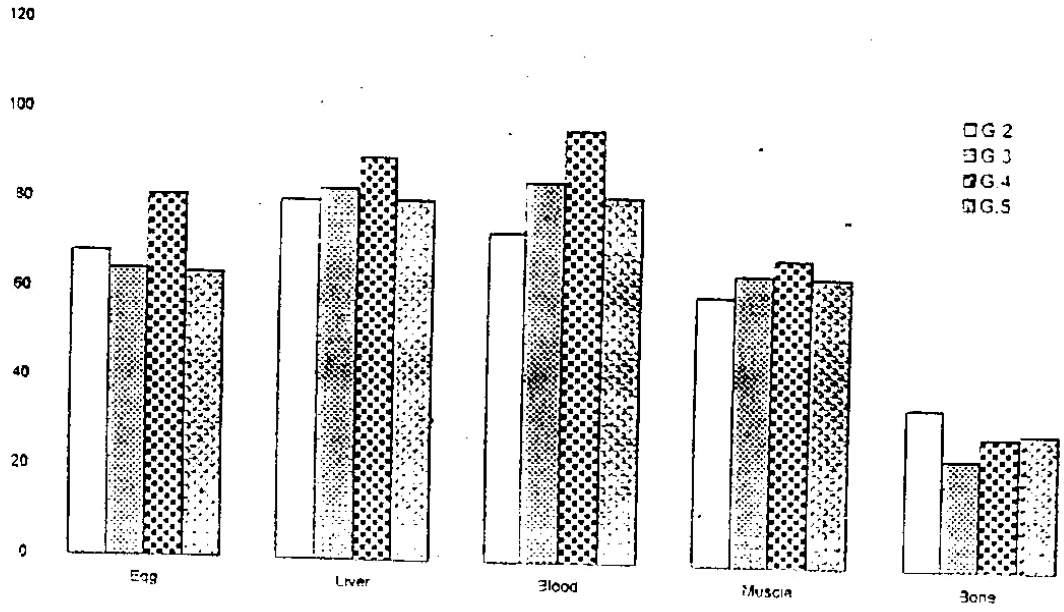

fig. (1) : Withdrawal rate of cadmium in egg, liver blood, muscle and bone of hens intoxicated by cadmium (G2 and G. 3) and hens administered cadmium plus Ca. edta (G. 4 and G.5).

DISCUSSION

Cadmium level in eggs of control, intoxicated and group-administered cadmium plus Ca. EDTA is similar to those recorded previously *(3, 4, 7)*. The delay in withdrawal may be due to the fact that cadmium needs certain time to be excreted from the kidney.

Ca EDTA is used as a chelating agent to eliminate and excrete the cadmium from tissue *(8)*. Cadmium is particularly deposited in eggs collected from intoxicated hens. This means that, eggs yielded from hens subjected to cadmium toxicity can't be consumed at least 2 months post stopping cadmium administration.

Cadmium levels in liver haves show a marked decrease by time since stopping cadmium intake specially in groups taken cadmium plus Ca EDTA (group 3 & 4) but still significantly higher than control even after 10 weeks. It is clear that more than 80% of total cadmium content in liver of treated groups were excreted through this period (10 weeks). It is suggested that liver is able to eliminate cadmium, perhaps through of metalothionin formation *(11)*. High level of cadmium content in liver collected from intoxicated birds has been recorded by many authors *(3, 5, 7, 12)*.

From our analytical results of cadmium level in hepatic tissues, we can advise that human being, specially children, should not consume the livers of cadmium intoxicated hens even after 10 weeks post last exposure.

It is clear that more than 95% of total blood cadmium content (specially groups treated by cadmium plus Ca EDTA) were excreted during 10 weeks of post-administraion . These may be attributed to stopping of cadmium exposure and using the chelating agent (Ca EDTA) *(8)*.

Residual amounts of cadmium were detected in different groups of hens administered cadmium or cadmium plus Ca EDTA. Similar results were cited early and recorded the accumulation of cadmium in kidney, liver, muscle and brain of trout fish after oral doses of cadmium chloride *(11)*. Ten weeks post exposure, muscle tissue could be saftly consumed specially when hens are treated with Ca EDTA . Cadmium level in the bone is the similar to those previously cited *(7, 13)*. The rate of cadmium excretion from bone was very slow. Also accumulation of cadmium in bone is higher than other tissues under this study.

CONCLUSION

1-Cadmium is bio-accumulate in large amount in bone then liver, egg, blood and muscle.

2-Withdrawal rate of cadmium is rapid from blood, liver, egg and muscle specially Ca EDTA treated hens. But the excretion of cadmium from bone is very slowly.

3-Estimation of cadmium content in egg reflecting directly the extent of cadmium pollution.

4-Egg and muscles from hens previously intoxicated with cadmium need at least 3 months, since stopping intake with plus Ca EDTA, to be consumed saftly . While liver and bone should not be consumed for human and animals even after this period.

REFERENCES

1-Mahaffey, K. R.; Corneli Vssen, P. E.; Jelimek, C. F. and Fiorino, J. A. (1975): Heavy metal exposure from foods. Environ. Health perspect. Dec.; 12: 63-69.

2-Yoshiki-S; Yanagisawa, T.; Kimura, M.; Otaki, N.; Susuki, M. and Suda; T. (1975): Bone and kidney lesions in experimental cadmium intoxication. Archives of Environmental-Health. 30: 11, 559 - 562.

3-Vogt, H.; Matthes, S. and Nezel, K. (1977): Effect of supplements of cadmium in feeds for broilers and laying hens on performance and amount of residues in tissues and eggs. 1. Effect of cadmium on performance. Archiv-fur-Geflugel kunde. 41: 1, 1-9.

4-Rombough, P. J. and Garside, E. T. (1982): Cadmium toxicity and accumulation in eggs and alerins of Atlantic Salmon Salmo Salar. Candian-J-of zoology 60: 8, 2006-2014.

5-Blalock-T. L. and Hill, C. H. (1988): Studies on the role of iron in the reversal of cadmium toxicity in chicks. Biological-Trace Element-Research. 17: 247-257.

6-Talmage, S. S. and Walton, B. T. (1991): Small animals as monitors of environmental contaminations. Rev. Environ. Contain toxicol. 119: 47-145.

7-Baurnane, V.; Valiniece, M. and Babarikins, D. (1996): Effect of cadmium on egg production and Cd. distribution in eggs and tissues of hens. Natural-sciences. 50: 3, 97-102.

8-Clarke, E. G. C. and Myral, C. (1975): ...Veternary toxicology First Ed. Printed offset litho in Great Brition by Cox and Wyman Ltd., London, Fakenham and Reading.

9-A.O.A.C. (1997): Official methods of analysis of AOAC International. 16th Ed. 3rd Revision, Vol. 1. Goithersbug. Mryland, USA.

10-Clarck, G. and Cooke, D. (1983): A basic course in statistics ...second edition English language book society Edward Arnold.

11-Melgar, M. J.; Perez, M.; Garcia, M. A.; Alonso, J. and Miguez, B. (1997): The toxic and accumulative effects of short-term exposure to cadmium in rainbowtrout (oncorhynchus mykiss). Veterinary-and Human toxicology. 39:2, 79-83.

12-Neathery, M. W. and Miller. W. J. (1976): Cadmium toxicity and metabolism in animals Feed stufs. 48 : 3, 30 - 32.

13 -Richardson, M. E. Spivey - Fox, M. R. and Fry , B. E. (1974) : Pathological changes produced Japanese quality by ingestion of cadmium Journal of Nutrition , 104 : 3 , 323 - 338.

الملخص العربى

معدل التخلص من متبقيات الكادميوم من البيض وبعض أنسجة دجاج بلدى سبق تعرضة للكالدميوم

رجب محمود الشواربى نبيلة محمود عبدالعليم

قسم الطب الشرعى والسموم ، كلية الطب البيطرى - جامعة الزقازيق - فرع بنها

تعتبر المعادن الثقيلة أحد أهم ملوثات البيئة الموجودة فى الماء والغذاء والهواء الذى يتعرض له الأنسان والحيوان ويعتبر الكادميوم أحد هذه الملوثات والذى أجريت عليه دراسات كثيرة لغرض توضيح سميته . وفى هذه الدراسة تم محاولة التعرف على المدة التى تلزم لتخلص بعض أنسجة الدجاج البلدى من ملوث الكادميوم وكذلك دور الكالسيوم أدتا فى سرعة تخلص الجسم من الكادميوم إستخدمت مائة وخمسون دجاجة قسمت إلى خمسة مجموعات بالتساوى . أحتفظت بالمجموعة الأولى كمجموعة ضابطة . وأضيف الكادميوم بنسبة ١٠ ، ٢٠ جزء فى المليون فى مياه الشرب للمجموعة الثانية والثالثة على التوالى بينما أعطى الكادميوم بنفس النسبة مع أضافة ٧٥ مجم/كجم من وزن الجسم مرة أسبوعيا من الكالسيوم أدتا إلى مياه الشرب للمجموعة الرابعة والخامسة على التوالى . أستمرت التجربة لمدة ١٠ أسابيع متتالية . تم ذبح عدد خمسة من دجاج كل مجموعة بعد إنهاء التجربة مباشرة ثم بعد ٢ ، ٤ ، ٦ ، ٨ ، ١٠ أسابيع . وأخذت عينات من كل المجموعات عند نفس الفترات والعينات كانت عبارة عن (بيض - كبد - دم - عضلات - عظام) وذلك لقياس المتبقى من الكادميوم . أوضحت النتائج وجود نسب مختلفة من الكادميوم فى تلك العينات والتى كانت أكثر ما يمكن عند توقف التجربة ثم بدأت فى النقص مع مرور الوقت . يحتاج البيض والعضلات إلى حوالى ثلاثة شهور لكى تصبح صالحة للإستهلاك الأدمى خاصة بعد إضافة الكالسيوم إديتا . فى حين يكون الكبد والعظام غير صالحة حتى بعد مرور ثلاثة شهور. كما أوضحت التجربة أن إضافة الكالسيوم إديتا يساعد على تخلص الجسم من الكادميوم .