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EFFECT OF FEEDING POLLUTED DIETS WITH ALUMINUM ON LAYING HENS

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ABSTRACT

A total number of 60 Hy-line W36 hens at 18 weeks of age were used in an experiment lasted 33 weeks were randomly assigned to each of three feeding treatments (20 / treatment). The experiment aimed to study the effect of feeding diets polluted with aluminum on laying hens. The first treatment was fed the basal diet as a control, while the other two treatments were fed basal diet supplemented with 500 or 1000 ppm aluminum (Al) as aluminum chloride ($Al.Cl_3.6H_2O$).

Results obtained could be summarized as follows:

Aluminum (Al) at 500 or 1000 ppm levels recorded decreased in body weight and body weight change at the end of the experimental period.

Egg production, egg number and egg mass for hens treated with supplementation of Al recorded decreased during the experimental period.

Feed intake differ statistically ($P<0.05$) among the different feeding groups. Feed conversion ratio recorded a non significant difference between groups.

Egg quality expressed as egg yolk percentage were increased ($P<0.05$), while egg shell, yolk index and Haugh units recorded a non significant difference between groups.

Aluminum concentration in egg yolk, albumen and eggshell over those of the control group, while Al concentration lower than that of eggshell.

The negative effect of various Al supplement a non significant increase in percentage of liver, spleen and abdominal fats, while gizzard and heart percentage recorded a significant differences ($P<0.05$) compared to the control group.

Aluminum causes significantly ($P<0.01$) increased Al in muscle and bone, while liver, heart and gizzard were not significant recorded increased as compared to the control group.

Digestibility of OM, CP, CF and EE were significantly varied ($P<0.05$) among the experimental groups.

The results of this study indicate that when layer hens diet is polluted with aluminum, it is toxic and causes a heavy losses in egg industry and causes negative effects on productive performance, utilization of nutrients, body weight gain, egg production, egg quality. There is a possibility of hazardous effects on human health and animal health from feeding polluted diets, eggs and meat or generally, from environmental pollution.

Keywords: Hy-line W36 hens, Aluminum chloride, reproductive performance, Aluminum concentration, Digestion trials, carcass traits.

INTRODUCTION

Environmental pollution is one of the major obstacles which a pronounced deleterious to the quality and quantity of animal and agricultural products. The contamination of poultry ration was recently paid attention especially with the heavy metals which cause a big reduction in the body weight and feed intake and a great deterioration in the feed conversion and result finally in a great economic loss for Poultry men.

Aluminum is considered one of the major pollutions in the modern world, it is the third most abundant element in the earth's crust (approximately 8% of the crust is composed of aluminum compounds), main sources for the element are diets, air, feed additives, processed cheese, vaccines, toothpaste and normal tap water. dust and soil.

Burger (1994) reported that birds can rid their bodies of heavy metals through both excretion and deposition in feathers, and females can also eliminate heavy metals in the contents of their eggs.

The problem will be more serious if the human exposed to these heavy metals (Aluminum), Recent studies suggest that aluminum may be involved in the progression of Alzheimer's Disease, Parkinson's disease, Guam ALS-PD complex, "Dialysis dementia", Amyotrophic Lateral Sclerosis (ALS), senile and presenile dementia, neurofibrillary tangles, clumsiness of movements, staggering when walking and an inability to pronounce words properly (Shore and Wyatt, 1983 and Goyer, 1991).

The principal symptom of aluminum poisoning is the loss of intellectual function, forgetfulness, inability to concentrate, Chronic aluminum exposure has contributed directly to hepatic failure, renal failure, and dementia (Arieff *et al*., 1979).The aluminum content of feedstuffs is influenced by mode of harvesting and feed processing.

There are few studies which examine the effects of an increased aluminum intake on the aluminum content of foodstuffs of animal origin (Schenkel and Kluber, 1987).

Berlyne *et al*.(1972) reported that the primary effect of Al toxicity is to deplete phosphorus, thereby indirectly affecting feed intake and body weight. Storer and Nelson (1968) reported that levels of 0.1 to 0.4% Al reduced growth and feed efficiency in Single Comb White. However, it is normally found at very low levels or high levels of dietary aluminum have been shown to have negative effects on growth, calcium and phosphorus metabolism (Hassein *et al.,* 1988).

There is little information in the literature concerning the effect of dietary aluminum (Al) on productive performance of laying hens.

The present study aimed to investigate the effects of aluminum (Al) in different concentrations on productive performance, egg production, egg quality, carcass traits, digestibility and residuals aluminum (Al) in eggs and carcass of laying hens.

MATERIALS AND METHODS

The Present experiments were carried out at the Poultry Breeding Farm of Poultry Production Department, Faculty of Agriculture, Ain Shams University. A total of sixty Hy-line w36 hens at 18 weeks of age were used in an experiment lasted 33 weeks were randomly assigned to each of three feeding treatments, (20 / treatment). The first treatment was fed the basal diet as a control, while the other two treatments were fed basal diet supplemented with 500 or 1000 ppm aluminum (Al). The source of supplemented aluminum was aluminum chloride ($Al.Cl_3.6H_2O$). They were housed in 15 cages (replicates 4 birds in each). Hens kept on 14 hours light each day. Feed and water supplied *ad libitum*. All hens were kept under the same managerial, hygienic and environmental conditions, All birds were vaccinated against Newcastle disease and Fowl Pox disease during laying period, they were fed formulated in mash form to meet the recommended nutrient requirements for laying hens according to NRC (1994) as shown in table(1).

During the experimental period (18-33 weeks of age) individual live body weight and feed intake were determined biweekly. Feed conversion ratio (kg feed intake / kg egg mass) was calculated and the mortality was recorded every day it occurred. Eggs were collected daily and weighed for each group, so egg number, egg mass were calculated. Egg mass of hen was calculated as weight of egg on egg number of hens.

Egg quality was measured when the egg production recorded 50 percent (5 eggs/ treatment). Haugh units, egg yolk weight, eggshell weight, albumen weight were determined. Haugh units for each individual egg according to (Elsen et al., 1962).

Aluminum concentration in tissues and eggs (5 eggs/ treatment) were quantitative by ICP-DES-MS.

At the end of the experiment, five birds (33 weeks of age) were randomly selected from each treatment ,fasted over night. They were killed by slitting the jugular vein, then scalded and defeathered Carcasses were eviscerated manually and liver, heart, gizzard and spleen were weighed. Abdominal fats were removed and weighed and the weights of these organs were expressed as percent of live weight.

At the end of the experimental feeding period, digestion trials were conducted using 9 naked neck cocks (3 birds each treatment), to determine the digestibility coefficients of the experimental diets. Birds were housed individually in metabolic cages. The digestibility trials extended for 8 days of them 5 days as a preliminary period followed by 3 days as collection period. The individual live body weights were recorded during the main collection period to determine any loss or gain in the live body weights. During the main period, excreta were collected daily and weighed, dried at 60^{o} C bulked, finally ground and stored for chemical analysis. Urinary organic matter was calculated according to Abou-Raya and Galal (1971). Fecal nitrogen was determined according to Jakobsen *et al*.(1960).

The proximate analysis of feed, meat and dried excreta were carried out according to A.O.A.C.(1990).

Aluminum (Al) in yolk, albumin and egg shell were determined according to Jeng and Yang (1995).

Data obtained were subjected to statistically analyzed by the computer program of SAS (1996) using the general Linear Models (GLM) and differences among means were separated by Duncan's New Multiple Range Test (Duncan, 1955).

Table 1: The composition and proximate chemical analysis of the experimental diet.

Ingredients	Control diet
Yellow corn	61.8
Soybean meal (48%CP)	19.3
Gltufied (16% CP)	4
Corn gluten meal	2.9
Bone meal	1.8
Decorticated cotton seed meal	2
Limestone	7.42
Vit. and min. premix*	0.4
Dl-methionine	0.04
L-lysine	0.02
Salt	0.32
Total	**100**
Proximate chemical analysis %	
Crude protein	18
Crude fiber	2.8
Ether extract	2.9
Calculated values	
Metabolizable energy (kcal/kg)**	2775
Avail. Phosphorus%	0.35
Calcium %	3.33
Methionine %	0.37
Lysine %	0.82
Methionine + Cystine %	0.61

*** Each 1 kg Vitamins and minerals premix contain, Vit. A 120000 IU, Vit. D_3 22000 IU, Vit.E100 mg, Vit.K_3 20mg, Vit. B_1 10 mg, Vit. B_2 50 mg, Vit. B_6 15 mg, Vit.B_{12} 100 µg, Pantothenic acid 100 mg, Niacin 300 mg, Folic acid 10mg, Biotin 500 µg, iron. 300mg, Manganese 600 mg, Choline chloride 500 mg, Iadine 10 mg,Copper 100 mg, Seleneium 1 mg, Zinc 500 mg and 1200 mg Antioxidant.**

****Metabolizable energy Calculated according to NRC of poultry (1994).**

RESULTS AND DISCUSSION

Productive performance

Effect of feeding different levels of aluminum (Al) on productive performance by laying hens during the experimental period (18-33 weeks of age) was summarized in table (2). Considering the whole experimental period (18-33 weeks), it is clear that supplementation of Al at 500 or 1000 ppm levels did not cause any significant depression in body weight and body weight change. It is worthily noting that decreasing of the body weight change during the whole experimental period (18-33 weeks) was 8.20 and 16.39% in birds fed diets supplemented with 500 ppm and 1000 ppm Al, respectively, as compared to the control group. Similar results were reported with Storer and Nelson (1968) who found that levels of 0.1 to 0.4% Al as aluminum sulphate reduced growth in Single Comb White Leghorn chicks. Sooncharernying and Edwards (1990) showed that supplementation Al at 500 mg/kg decreased body weight.

Feed intake were significantly ($P<0.05$) different for layer hens treated with levels of aluminum as shown in table (2).

These results show that the feed intake for level of 500 ppm Al, it was decreased by about 2.89 %, while there is an increase in the 1000 ppm Al level by about 1.23 % as compared to the control group.

Table 2: Effect of feeding different levels of aluminum on productive performance ($\bar{X}$±SE) of laying hens.

Items	Treatments		
	Control	500 ppm	1000 ppm
Initial body weight (g)	1198.5±13.03	1219.27±17.11	1242.5±15.13
Final live body weight (g)	1471.58±20.6	1470.21±23.80	1470.82±24.6
change in body wt (g/day)	2.44±0.39	2.24±0.34	2.04±0.24
Feed intake (g/day)	96.23±0.75 [a]	93.45±0.54 [b]	97.41±0.41[a]
Egg production %	85.54±2.03	82.33±2.66	84.41±1.99
Egg weight (g)	51.21±0.90	51.68±0.18	51.53±0.53
Egg number/d	0.86±0.77	0.82±0.53	0.83±0.48
Egg mass (g egg/d)	44.04±0.11	42.38±0.15	42.77±0.24
Feed conversion (kg feed/ kg egg)	2.19±0.25	2.21±0.18	2.28±0.31

[a, b] **Means with different letters in the same row are significantly different at ($P< 0.05$).**

These results were in agreement with Berlyne *et al*.(1972) reported that the primary effect of Al toxicity is to deplete phosphorus, thereby indirectly affecting feed intake and weight. Hussien *et al*.(1989[b]) found that feed intake and egg production were significantly reduced with 0.15% level of Al in laying hens. Ronald (1988) who found that addition Al to layer diet reduced feed consumption, with no effect on egg weight.

The Al fed did not affect significantly egg production, egg weight, egg number, egg mass and feed conversion ratio (Table 2).

Results showed that diet polluted with 500 and 1000 ppm Al did not affect significantly on egg production percentage in laying hens. These results were in agreement with Carrier *et al*.(1986) they found that the aluminum (0.1%) did not result in any effect on egg production, fertility or hatchability. Hussien *et al*.(1989[a]) found that dietary aluminum (0.3%) reduced egg production in hens. Hussien *et al*.(1988) who found that egg production were significantly reduced with 0.15% Al in laying quail, mainly due to depressed feed intake and that on Calcium and Phosphorus metabolism

The egg number decreased in 500 and 1000 ppm Al by about 4.65 and 3.49 % as compared with the control group, respectively. The control group was higher than the other treatments in egg mass of during the experimental period.

Results of feed conversion ratio (kg feed intake/ kg egg mass) revealed a non significant among the experimental groups, data shows that feed conversion ratio decreased with increasing of Al level in diet.

Generally, the presented study shows that the feed conversion ratio was worst in the 500 or 1000 ppm Al fed group, respectively. Sooncharernying and Edwards(1990) who found that supplemental Al as low as 500 mg/kg had an adverse effect on feed efficiency. Wisser *et al*.(1990) found that Al at 0.30% of diet severely decreased feed efficiency in hens.

Egg quality and contamination

Data of the effect of graded levels of Al supplementation on egg quality are presented in table (3).

Result shows that the egg yolk percentage for 500 and 1000 ppm Al were increased ($P<0.05$) by about 5.88 and 16.24 % as compared with the control group, respectively, while percentage of albumen, egg shell, yolk index and Haugh units were recorded non significant differences as compared to the control group.

Table 3: Effect of feeding different levels on aluminum (AL) on egg quality traits ($\bar{X}$ ±SE) of laying hens.

Items	Treatments			Sig.
	Control	500 ppm	1000 ppm	
yolk %	25.86±0.74 [b]	27.38±0.38 [a]	30.06±1.70 [a]	*
albumin %	64.80±0.75	63.29±0.35	63.61±0.86	n.s
Egg shell %	9.34±0.05	9.33±0.04	9.33±0.03	n.s
Yolk index %	49.19±1.65	49.62±2.51	49.24±1.11	n.s
Haugh units	108.0±2.77	109.0±1.03	106.2±1.07	n.s

[a, b] Means with different letters in the same row are significantly different.
sig.=Significance, n.s= non significant, *= (P< 0.05).

The exposure to Al at the two doses of 500 and 1000 ppm not significantly increased the Al concentration in yolk, albumen and egg shell over those of the control group (Table 4).

Table 4: Aluminum concentration (ppm) in egg ($\bar{X}$ ±SE) of laying hens.

Items	Treatments			Sig
	Control	500 ppm	1000 ppm	
Albumen	23.41±1.66	25.98±1.76	25.07±1.27	n.s
Yolk	20.69±1.94	22.27±1.77	24.03±2.33	n.s
Egg shell	14.68±1.11	16.58±1.03	16.91±1.40	n.s

Sig. = Significance, n.s = non-significant.

It is worthy noting that the residuals Al of 500 ppm resulted in 1.10, 7.64 and 12.94 % higher in albumen, yolk and egg shell, while the residuals Al of 1000 ppm resulted in 7.09, 16.14 and 16.19% higher in albumen yolk and egg shell than that of the control group, respectively.

Carcass traits and contamination

The negative effects of dietary aluminum levels on carcass traits are shown in table (5), it is clear that supplementing Al causes non significant increases in percentage of liver, spleen and abdominal fats, while gizzard and heart percentage recorded a significant differences ($P<0.05$) as compared to the control group.

Table 5: Carcass traits of laying hens as affected by different levels of dietary Al ($\bar{X}$ ±SE).

Items	Treatments			Sig.
	Control	500 ppm	1000 ppm	
Liver %	1.69±0.0	1.81±0.11	1.74±0.09	n.s
Gizzard %	1.21±0.02	1.44±0.05 [b]	1.63±0.03	*
Spleen %	0.09±0.0	0.09±0.05	0.11±0.03	n.s
Abdominal fats %	1.99±0.4	2.053±0.51	2.88±0.41	n.s
Heart %	0.40±0.12 [a]	0.37±0.15 [a b]	0.35±0.19 [b]	*

[a, b] Means with different letters in the same row are significantly different.
sig.=Significance, n.s= non significant, *= (P< 0.05).

The negative effect of Al level in some tissue are shown in table (6), it is clear that Al supplementing of hen diet significantly ($P<0.01$) increased concentration in muscle and bone, while liver, heart and gizzard were not significant increased concentration as compared to the control group.

Table 6: Aluminum concentration (ppm) in some tissues ($\bar{X}$ ±SE) of hens fed diets containing different levels of aluminum.

Items	Treatments			Sig
	Control	500 ppm	1000 ppm	
Muscle	3.86±0.51 [b]	8.26 ±0.26[a]	9.65 ±0.91 [a]	**
Liver	12.16 ±0.56	15.15 ±2.07	16.98 ±0.91	n.s
Heart	26.49 ±2.24	30.07± 3.52	35.96± 2.68	n.s
Gizzard	13.45 ±2.93	12.22±1.90	16.5 0±.95	n.s
Bone	30.82 ±2.51 [b]	47.33± 10.2 [a]	53.62± 7.32 [a]	**

[a, b] Means with different letters in the same row are significantly different.
sig.=Significance, n.s= non-significant, **= (P< 0.01).

It is worthy noting that the residuals Al of 500 or 1000 ppm resulted in 114 and 150% in muscle higher than of the control group, respectively.

The problem will be more serious if the human exposed to these heavy metals (Aluminum) from eating polluted meat or eggs as a long-term. Hence, the human are being suffered a chronic poisoning. In this respect, the poison will be concomitant with several dangerous diseases.

Other symptoms that have been observed in individuals with high internal concentrations of aluminum are colic, convulsions, esophagitis, gastroenteritis, kidney damage, liver dysfunction, loss of appetite, loss of balance, muscle pain, psychosis, shortness of breath, weakness, and fatigue (Atsdr, 1990).

Digestibility coefficients

The apparent digestion coefficients of nutrients for the different experimental diets is presented in table (7).

The digestion coefficient of OM, CP, CF and EE and were decreased ($P<0.05$) at the low or high level of Al.

Table 7: Digestibility coefficients ($\bar{X}$ ±SE) as affected by levels of aluminum on experimental diets.

Items	Treatments			Sig.
	Control	500 ppm	1000 ppm	
OM %	74.16±1.56[a]	71.26 ±1.69 [b]	69.74±1.98 [b]	*
CP %	88.75±0.96 [a]	65.65±1.38 [b]	65.09±1.61 [b]	*
CF %	30.51±1.53[a]	26.75±1.61[b]	24.01±1.70 [b]	*
EE %	85.63±2.20 [a]	84.79±2.36[a b]	82.09±2.68 [b]	*

[a, b] Means with different letters in the same row are significantly different.
sig.=Significance, *= (P< 0.05).

Generally, These results indicated that diets polluted with Al were negative effect on nutrient utilization, these may be due to the affect of Al on some of enzyme systems and biochemical parameters These result were confirmed with Bokori *et al.*(1993) who reported that the very poor feed utilization in fowls with the Al diet was attributed to disturbance of base balance of diets.

In conclusion, the results of this study indicate that when layer hens diet is polluted with aluminum, it is toxic and causes a heavy losses in egg industry and causes negative effects on productive performance, utilization of nutrients, body weight gain, egg production, egg quality. There is a possibility of hazardous effects on human health and animal health from eating polluted diets, meat and eggs or generally, from environmental pollution.

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تأثير تغذية الدجاج البياض على العلائق الملوثة بالألمونيوم

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اجري هذا البحث لدراسة تأثير التغذية على العلائق الملوثة بالألمونيوم علي أداء الدجاج البياض حيث غذيت ٦٠ دجاجة بياض (هاي لاين)عمر ١٨ أسبوع ، قسمت إلى ثلاث معاملات في كل معاملة ٢٠ دجاجة. غذيت المعاملة الأولى(المقارنة) على عليقه بياض بدون إضافة الألمونيوم و العاملتين الأخيرتين غذيتا علي عليقه ملوثة بالألمونيوم في صورة كلوريد الألمونيوم بمستويات ٥٠٠ , ١٠٠٠ جزء في المليون .
ويمكن إيجاز أهم النتائج في النقاط التالية :
- اثر تلوث العلائق بالألمونيوم تأثيرا سلبيا و غير معنوي على التغير في وزن الجسم , حيث سجلت المعاملة المغذاة علي ١٠٠٠ جزء في المليون اكبر القيم انخفاضا .
- سجلت المجموعة المعاملة المغذاة عند مستوي ٥٠٠ جزء في المليون انخفاض في معدل استهلاك العليقة حيث استهلكت عليقة اقل من مجموعة المقارنة بنسبة ٢,٨٩ ٪ بينما المجموعة المعاملة عند مستوي ١٠٠٠ جزء في المليون استهلكت عليقة اكثر من مجموعة المقارنة بمقدار ١,٢٣٪ .

- اثر تلوث العلائق بالألمونيوم تـأثيرا سلبيا علـي النسبة المئويـة لانتـاج البيض ,حيث سجلت معاملـة الإضـافة عند مستوي ٥٠٠ جزء في المليون اقل القيم.
- تلاحظ أن هنـاك تـأثيرا سـلبيا علـي عدد و كتلـة البـيض نتيجـة التلـوث بـالألمونيوم وكـان التـأثير السـلبي غيـر معنوي.
- بالنسبة لمعدل تحويل الغذاء (كجم غذاء مستهلك / كجم كتلـة البيض) فقد تلاحظ آن هنـاك تـأثيرا سلبيا نتيجـة التلوث بالألمونيوم .
- تلاحظ أن هنـاك تـأثيرا سلبيا علـي صـفات البيضـة نتيجـة التلـوث بـالألمونيوم فيمـا عدا النسبة المئويـة لصـفار البيضة حيث تلاحظ وجود زيادة معنوية سالبة نتيجة المعاملة .
- لـم يلاحـظ أي تـأثير معنـوي علـي صـفات الذبيحـة نتيجـة التلـوث بـالألمونيوم لكـل مـن النسـبة المئويـة للكبـد والطحال ودهن البطن بينما تأثيرات النسبة المئوية لكل من القونصه والقلب .
- ازداد تـراكم عنصـر الألمونيـوم فـي أنسـجة الطيـور ومكونـات البيضـة, فقد أوضـحت القياسـات إن الزيـادة تتناسب طرديا مع زيادة تلوث العليقة , ولوحظ أن العظام اكثر تراكما لعنصر الألمونيوم .
- لوحظ تأثيرا سلبيا ومعنويا علي معاملات هضم المادة العضوية والبروتين الخام و الأليـاف الخـام ومستخلص الاثير وقد ازداد التأثير السلبي بزيادة نسبة التلوث.

يتضح من النتائج السـابقة أن هنالـك تـأثيرا سلبيا علـي الأداء الإنتـاجي للدجاج البيـاض نتيجـة للتلـوث بعنصـر الألمونيـوم كملـوث مـن ملوثـات البيئـة، و ذلـك نتيجـة لحـدوث خلـل فـي التمثيل الغذائي للطيـور و التـي ظهرت في التأثير السلبي على معـاملات هضم الغذاء و وزن الجسم و إنتـاج البيض و جودتـه و بالتـالي هنالـك إمكانية لحدوث مضاعفات علي صحة الإنسان نتيجة لتناول الأغذية (بيض- لحم) الملوثة بعنصر بالألمونيوم.