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Effect of High Dietary Aluminum as a Force Resting Agent on Fertility and Hatchability Parameters of Laying Hens

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Abstract. A total of 416 Saudi Arabian Baladi laying hens were divided into four experimental groups, four replicates each. The experimental groups were subjected to the following treatments: Commercial laying ration (17% CP, 3.6% Ca and 0.343% available P) fed *ad libitum* as a control (C); Conventional force molting, feed removal for 10 days followed by 18 days full feed of cracked corn (F); 15 days *ad libitum* intake of the control ration supplemented with 0.35% AL as the sulfate (ALS) or chloride (ALC). The birds were in production for 52 weeks and 17 months old at the start of the experimental period. Three males of the same age were added to each replicate.

Production period had a significant ($P < .05$) effect on fertility, hatchability and embryonic mortality during 1-7 and 19-21 days of the incubation period, whereas treatment and their interaction effects were not significant with respect to all parameters studied. Though, feed-restricted and AL treated hens tended to have lower performance, force resting by means of feed restriction or feeding excessive amount of AL seems to have no significant influence on fertility and hatchability parameters.

Introduction

Reports on the effect of force molting on fertility and hatchability of domestic chickens are very limited. Hall [1] reported higher fertility and hatchability for molted hens by means of restricted feeding with or without light restriction compared with nonmolted hens. Similar trend was found by Pino [2] for hens molted conventionally or by feeding 0.1% enheptin. Hansen [3] observed that fertile hatchability was lower for progesterone treated hens during the first three months after molting in comparison with those molted by means of feed restriction or feeding 0.15% enheptin. Perdomo *et al.* [4] stated that fertility of eggs from hens rested by feeding iodine was not affected during the iodine feeding period, however delayed hatching, higher embryonic mortality and lower fertile hatchability were found for iodine treated hens compared with the control. Similar results were reported by Arrington *et al.* [5]. Palafox and Ho-A [6] reported lower fertility and hatchability of pullet eggs collected 14-28 days after feeding 20000 ppm zinc for five days. Stahl *et al.* [7] concluded that feeding 20-2000 ppm zinc for a period of 12-44 weeks did not seem to influence fertility and hatchability of laying hens.

High dietary aluminum levels have been shown to influence phosphorus metabolism and to have negative effect upon laying hen performance [8-12]. On the other hand, Hussein *et al.* [12] did not detect any significant difference in subsequent feed intake, egg production and shell breaking strength of hens force-rested conventionally and those subjected to high dietary aluminum treatment. However, our knowledge on the effect of high dietary aluminum on fertility and hatchability parameters are obviously lacking. The present study was therefore conducted to investigate in Saudi Arabian Baladi laying hens the following aspects:

1- The effect of high dietary aluminum (as the sulfate or chloride) as a force resting agent on fertility and hatchability parameters.

2- To compare the post-rest fertility and hatchability of aluminum treated hens with that of the control and hens subjected to conventional procedure.

Materials and Methods

A total of 416 leg-banded Baladi laying hens were used in this study. The hens were obtained from Saudi Arabian Baladi flock which has been randomly bred for several years in the experimental poultry and live-stock farm of the Animal Production Department, King Saud University. The experimental birds were randomly alloted to 16 floor pens in an environmentally controlled house, 26 birds in each pen and divided into four experimental groups of four floor pens. Hens were in production for 52 weeks and 17 months of age at the beginning of the experimental period. Three males of the same age were added to each floor pen. The different experimental groups were randomly assigned to each of the following dietary treatments:

1- Commercial laying ration (Table 1) as a control (C).
2- Conventional force molting: feed removal for 10 days followed by 18 days full feed of cracked yellow corn (F).
3- 15 days *ad libitum* intake of the control laying ration supplemented, to initiate forced-rest, with 0.35% aluminum as the sulfate "$Al_2(SO_4)_3 . 18H_2O$" (ALS) or the chloride "$AlCl_3$" (ALC).

The level of aluminum (0.35%) was approximately equal to the calculated level of available phosphorus (0.343%). Light was maintained constantly at 15h light: 9h dark. After the termination of the treatments, experimental birds received the com-

Table 1. Composition of the commercial laying ration*

Ingredient	%
Alfalfa (16%)	1.5
Yellow corn	39.250
Soyabean meal (48%)	18.765
Wheat (12.5%)	14.540
Wheat bran	9.345
Dicalcium phosphate	0.670
Local limestone (28-30% Ca)	11.375
Fat	1.205
Salt	0.285
Fish meal (61%)	2.500
Vitamin-mineral premix	0.400
Red carrotin	0.100
Methionine	0.065
Calculated nutrient composition:	
ME kcal/kg	2585
Crude protein%	17.476
Crude fat%	4.225
Crude fiber%	3.104
Calcium%	3.601
Total phosphorus%	0.604**
Available phosphorus%	0.343

* Manufactured by: Grain Silos and Flour Mills Organization, Riyadh.
**Analyzed 0.585% [15].

mercial laying ration described in Table 1. Maximum and minimum house temperatures were also recorded daily during the whole experimental period and weekly averages were obtained (Fig. 1). The trial lasted nine, 28 day periods.

Five eggs of each replicate were collected on the three consecutive days during the third week of each 28 day periods. Experimental eggs were stored at 10 – 12°C and relative humidity of 55-60% for not more than two days and were incubated on the third day of collection following standard hatchery practices. Due to the brown color of the egg shell, fertility determination by means of candling is not accurate. Therefore eggs seemed infertile and unhatched eggs were broken out at the end of

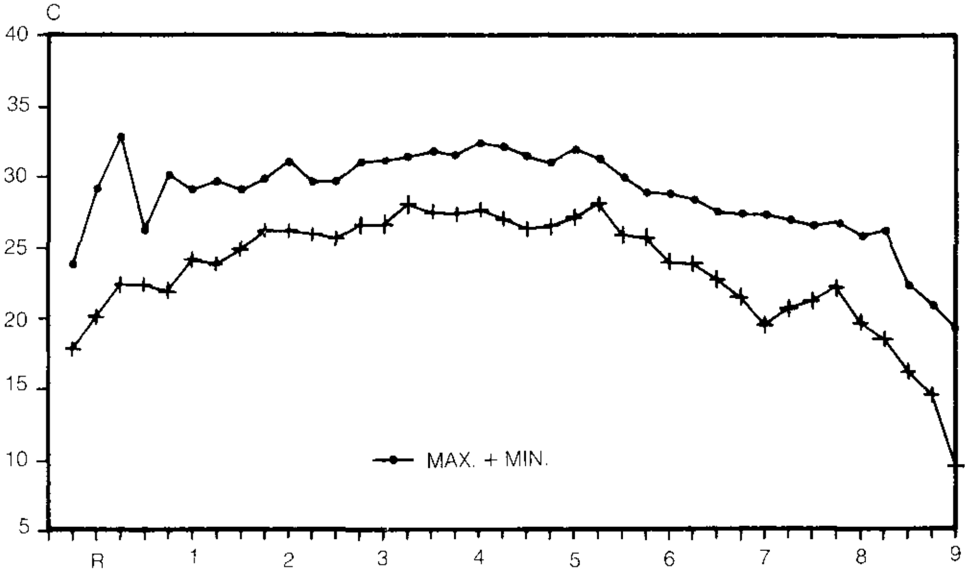

Fig. 1. Average weekly house temperature (°C) during the whole experimental period.

incubation period to determine fertility (FY), fertile hatchability (FH) and total embryonic mortality (TM) percentages. Percentages of the embryonic mortality at 1-7 (M1), 8-18 (M2) and 19-21 (M3) days of the incubation period and hatchability (H) as a percentage of total incubated eggs were also calculated.

Data collected were subjected to statistical analysis using SAS general linear model (GLM) procedure, KSU computer center, according to the following model:

$$Y_{ijk} = U + P_i + T_j + (PT)_{ij} + e_{ijk}$$

where:

Y_{ijk} is the K^{th} observation of the i^{th} production period (P) j^{th} treatment (T).

$(PT)_{ij}$ is the interaction between production period and treatment.

U is the general mean.

e_{ijk} is the random error associated with the Y_{ijk} observation [13].

Results

Fertility (FY): Table 2 shows that the production period effect was significant (P <0.5), whereas that of treatment and their interaction were insignificant. F and ALS had numerically the lowest whereas ALC recorded the highest fertility percentage. Figure 2 shows that fertility had the lowest value during the first and attained its highest value during the second production periods. However, fertility was generally high during most of the production periods.

Fertile hatchability (FH): As it is indicated in Table 2 treatment, production period and their interaction effects were insignificant. Aluminum fed groups tended to have lower FH compared with F and the control. However, ALS had numerically the lowest and the control the highest fertile hatchability.

Hatchability (H): Table 2 indicates that production period effect was significant (P <.05) whereas that of treatment and their interaction were insignificant. Numerically, ALS had the lowest and the control (C) the highest hatchability. Figure 2

Table 2. Effect of force resting induced conventionally (F) or by high dietary aluminum as the sulfate (ALS) or chloride (ALC) on subsequent fertility (FY), fertile hatchability (FH), hatchability (H) and total embryonic mortality (TM)

	Parameter			
	FY %	**FH** %	**H** %	**TM** %
Treatment (T)	**N.S.**	**N.S.**	**N.S.**	**N.S.**
F	91.44±2.88	91.70±1.46	83.77±2.91	8.30±1.46
ALS	91.34±1.42	87.13±2.11	79.70±2.35	12.66±2.11
ALC	93.77±1.16	88.68±1.65	83.27±1.97	11.32±1.65
C	92.92±1.44	93.04±1.30	86.43±1.78	6.96±1.30
Period (P)	*	N.S.	*	N.S.
TxP	N.S.	N.S.	N.S.	N.S.
Overall Mean	92.33±0.67	89.85±0.83	83.33±0.99	9.27±0.83

* P < .05

N.S. Insignificant

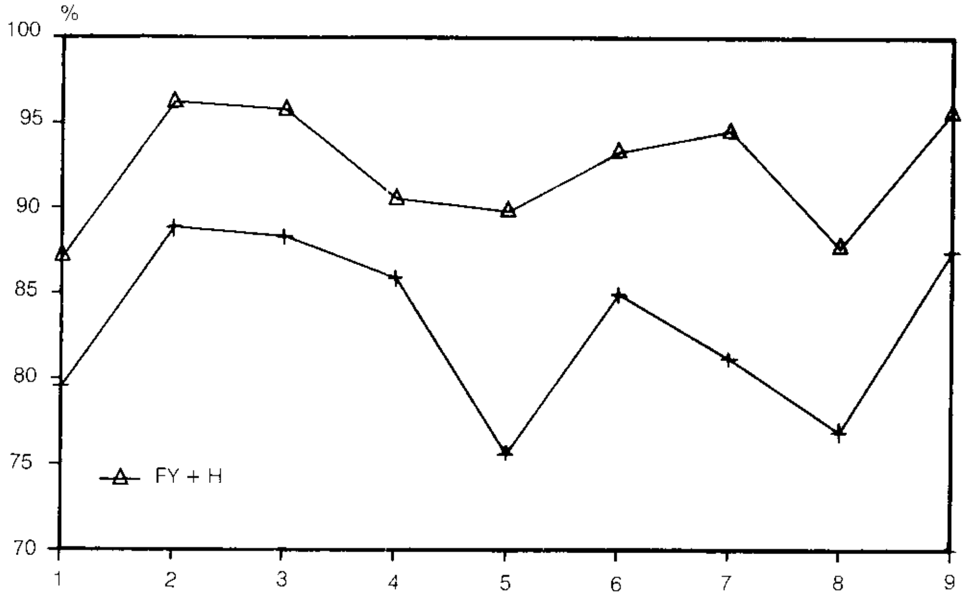

Fig. 2. Effect of production period on fertility (FY) and hatchability (H).

shows that hatchability attained its highest value during the 2nd and its lowest value during the 5th production periods. However during most production periods, hatchability values were higher than that of the 1st production period.

Total embryonic mortality (TM): As it is shown in Table 2 treatment, production period and their interaction effects were insignificant. ALS and ALC tended to have higher TM compared with F and the control (C). On the other hand, ALS had numerically the highest and the control the lowest TM.

Embryonic mortality during the different stages of incubation: Table 3 shows that production period had a significant ($P < .05$) effect only upon M1 and M3, whereas treatment and their interaction effects were insignificant. ALS tended to have the highest and the control the lowest M2 and M3, whereas ALC had numerically the highest and F the lowest M1. Figure 3 shows that M1 had the lowest value during the 2nd and the highest during the 5th production period. However, during most of the production periods M1 values were lower than that of the 1st production period. As it is shown in Fig. 3 M3 had the lowest value during period 9 and the highest value during period 7. However, M3 values during periods 3, 4, 6 and 9 were lower than that of the first production period.

Table 3. Effect of force resting induced conventionally (F) or by high dietary aluminum as the sulfate (ALS) or chloride (ALC) on subsequent embryonic mortality during 1-7 (M1), 8-18 (M2) and 19-21 (M3) days of the incubation period

	Parameter		
	M1 %	**M2** %	**M3** %
Treatment (T)	**N.S.**	**N.S.**	**N.S.**
F	1.86±0.61	2.06±0.76	4.38±0.98
ALS	2.80±0.66	2.61±0.79	7.24±1.47
ALC	3.86±0.87	1.53±0.55	5.93±1.23
C	2.72±0.80	1.40±0.49	2.84±0.81
Period (P)	*	N.S.	*
TxP	N.S.	N.S.	N.S.
Overall Mean	2.98±0.40	2.11±0.24	4.62±0.41

* $P < .05$

N.S. Insignificant.

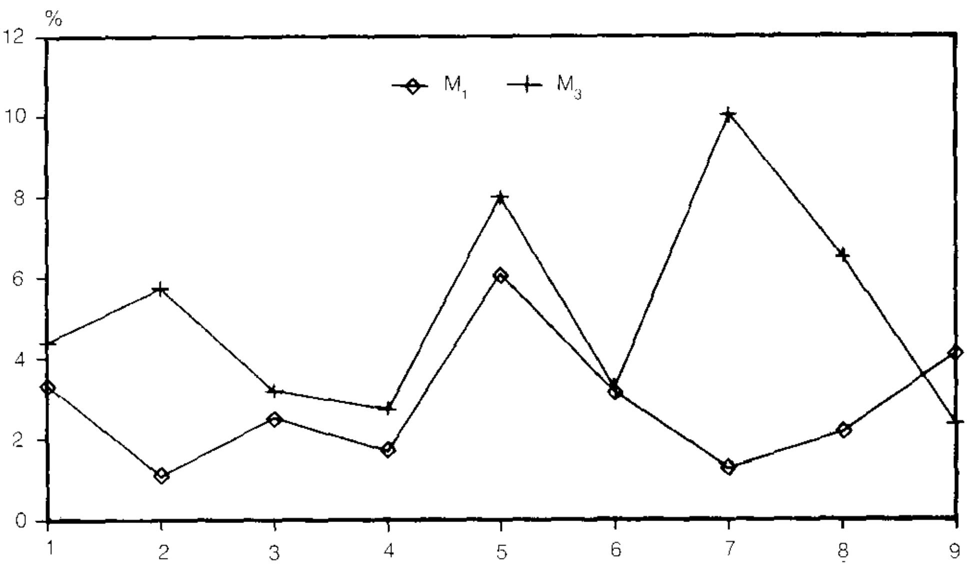

Fig. 3. Effect of production period on embryonic mortality during 1-7 (M1) and 19-21 (M3) days of the incubation period.

Discussion

Hens in the feed-restricted group tended to have lower fertility and hatchability but higher embryonic mortality compared with the control. Contrary to these results, Hall [1] and Pino [2] reported higher fertility and hatchability for White Leghorn hens molted by means of feed restriction. These differences might be attributed, among other factors, to breed effect.

Inclusion of 0.35% aluminum as the sulfate or chloride seems to have no influence upon subsequent fertility of laying hens. However, aluminum treated hens had numerically lower hatchability and higher embryonic mortality compared with feed-restricted and the control groups. Pino [2] reported higher fertility and fertile hatchability for hens molted by feeding 0.1% enheptin. Hansen [3] observed lower fertile hatchability for progesterone treated hens during the first three months following the molt compared with hens molted by means of feed restriciton or feeding 0.15% enheptin. Perdomo *et al.* [4] reported that fertility of eggs from hens rested by feeding 312-5000 ppm iodine was not affected during the treatment period, however delayed hatching, higher embryonic mortality and lower hatchability were found for iodine treated hens compared with the control. Similar results were reported by Arrington *et al.* [5].

However Palafox and Ho-A [6] reported lower fertility and hatchability of pullet eggs collected 14-28 days after feeding 20,000 ppm zinc for five days. On the other hand, Stahl *et al.* [7] concluded that feeding 20-2000 ppm zinc for a period of 12-44 weeks did not seem to influence fertility and hatchability of laying hens.

Compared with our results the same birds had during the first produciton year on the average 95.69, 90.60 and 6.71% fertility, fertile hatchability and total embryonic mortality, respectively [14].

From the results reported herein it may be concluded that force resting by means of feed restriciton or feeding excessive amount of aluminum as the sulfate or chloride did not seem to influence fertility and hatchability parameters.

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تأثير التوقف الإجباري عن الإنتاج عن طريق التصويم أو إضافة مستويات عالية من الأُلمنيوم للعليقة على الخصوبة ومعايير الفقس في الدجاج البلدي

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ملخص البحث. أجريت هذه الدراسة على عدد ٤١٦ طائرًا من إناث الدجاج البلدي عمر ١٧ شهرًا والتي قسمت إلى أربع مجاميع تجريبية من أربع مكررات وأخضعت للمعاملات التالية: (١) التغذية على عليقة بياض تجارية (١٧٪ بروتين خام، ٣,٦٪ كالسيوم، ٠,٣٤٣٪ فوسفور متاح) كمجموعة مشاهدة (C)، (٢) نظام قلش تقليدي عن طريق التصويم لمدة ١٠ أيام ومن ثم قدم للطيور ذرة صفراء مجروشة لمدة ١٨ يومًا (F)، (٣) ١٥ يومًا تغذية على عليقة مجموعة المشاهدة مضاف إليها ٠,٣٥٪ كبريتات أُلمنيوم (ALS) أو كلوريد (ALC). كذلك أضيف عدد ثلاثة ذكور بعمر الإناث إلى كل مكررة، وكان عمر الطيور ١٧ شهرًا عند بداية التجربة التي استمرت لمدة ٩ دورات إنتاجية كل منها ٢٨ يومًا.

دلّت النتائج على أن تأثير فترة الإنتاج كان معنويًا (P<.05) فيما يخصّ نسبة الخصوبة، نسبة الفقس التجارية، نسبة نفوق الأجنة خلال ١-٧ و ١٩-٢١ يومًا من فترة التفريخ، أما تأثير المعاملة وتفاعلها فقد كان غير معنوي على كل الصفات التناسلية المدروسة في هذه التجربة. ومع أن أداء الدجاج في معاملتي التصويم والأُلمنيوم كان يميل إلى الانخفاض نسبيًا، فإن إرغام الدجاج البلدي على التوقف المؤقت عن الإنتاج بواسطة التصويم لمدة عشرة أيام أو إضافة ٠,٣٥٪ كبريتات أو كلوريد أُلمنيوم يبدو أنه لا يؤثر على الصفات التناسلية المدروسة.