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# EFFECT OF FEEDING DIFFERENT LEVELS OF VITAMIN $D_3$ ON FERTILITY AND HATCHABILITY OF TWO LACAL STRAINS OF CHICKENS

**Khalifa, M. M. [1]; Tork M. I. Dorra[1]; Mervat A. Aly[1]; E.F. Abdel Hameid[2] and and A. F. Ibrahim[2]**

**1- Dept. of Poultry Prod., Faculty of Agric., Mansoura University.**

**2- Anim. Prod. Res. Inst. Agric. Res. Center, Ministry of Agric., Dokki, Giza, Egypt.**

## ABSTRACT

A total number of 1920 eggs were incubated from two strains of chickens at the 28th, 40th and 52th weeks of age .Hens were artificially inseminated twice a week throughout the experimental period. Eggs were randomly assigned to four treatments according to vitamin $D_3$ supplementation (0, 300, 600 or 1200 IU/kg of ration) for El-Mamourah as well as Sinai strains in each interval. Each treatment was assembled to three replicates 80 eggs each. The objective of this study was to investigate the effect of adding graded cholecalciferol levels (vitamin D3) to the layers diets on reproductive performance in both Mamourah (M) and Sinai (S) strains at different production periods.

**The obtained results can be summarized as follows:**

1- M eggs had significantly heavier egg weight loss percentage (11.51 %) during the whole period of incubation (0–18 days) than those of S ones (11.09 %).

2-Results indicated that increasing the cholecalciferol content in diet cursed increasing rate of egg weight loss during the whole period of incubation .

3-Results obtained showed that a reduction in egg weight loss percentage by advancing in age interval.

4- Egg fertility and hatchability in M strain was higher than those of S ones

5- Hens of both strains that fed the highest and the lowest levels of cholecalciferol had the highest and the lowest hatchability and the lowest and highest embryonic mortality, respectively.

6- It was noticed that hatchability (%) of all set or fertile eggs decreased in eggs laid early in a cycle (80.95 and 84.70 %), thereafter, it significantly increased reached its maximum value in eggs laid middle laying cycle (85.37 and 88.90 %) then hatchability (%) of all set eggs significantly decreased in eggs laid late laying cycle (82.03 %), whereas, hatchability (%) of fertile eggs slightly decreased in eggs laid in the same interval (88.28 %).

7- The results indicated that level of vitamin $D_3$ supplementation in the maternal diet was effective in improving absolute and relative (%) body weights of the progeny.

8- The significantly higher of economic efficiency (%) throughout the experiment was observed in chicks hatched from M eggs than those S ones by about (22.8 %). This improvement of economic efficiency may be due to increase of hatchability of M eggs as well as price of one M chick as compared to S ones. In addition to the previous mentioned discussion, the economic efficiency (%) responded positively to the increasing of levels of vitamin $D_3$ in maternal diets from 300 up to 1200 IU/kg feed and surpassed than those of the control group by about 17.6, 36.6, and 39.1 %, respectively

**Keywords**: strain, cholecalciferol, incubation, egg weight loss, reproductive performance.

## INTRODUCTION

The Mamourah is a local strain of chickens, developed in 1976 at the Montazah Poultry Research Station, from a cross between Alexandria males and selected inbred Dokki – 4 females (Abdel El–Gawad *et al*., 1976). while Sinai fowl is considered a new indigenous strain. It is a hybrid outcome of the natural crossing between unknown native breeds and foreign breeds, which was brought to Sinai province by the English soldiers who stayed thereafter in the end of Second World War, therefore, the birds took Sinai name. There was strong positive correlation between chclecalciferol content in poultry diet and chclecalciferol (*r* = o.995) and 25-hydroxycholecalciferol (*r* = 0.941) content in egg yolk (Mattila *et al*., 1999). It is now well established that cholecalciferol is metabolized first in the liver, then in the kidney-to 24,25$(OH)_2D_3$ or lα,25$(OH)_2D_3$ (Kodicek, 1974; DeLuca & Schnoes, 1976). The latter metabolite is known to be the active form of cholecalciferol in enhancing intestinal calcium transport (Holick *et al.,* 1971; Lawson *et al.,* 1971) and bone mineral mobilization (Tanaka & DeLuca, 1971; Raisz *et al.,* 1972). Avian embryos assimilate large amounts of calcium in their bones in a short time. The chicken embryo, for instance; accumulates over l00 mg of calcium from the egg shell across the chorioallantoic membrane from days 10-12 of embryonic life until hatching at day 21 (Simkiss, 1967;Tuan & Scott, 1977). Increase in hatchability was also observed by Abdulrahim *et al*., (1979) in an experiment conducted with 26-to 34-wk-old Leghorn laying hens by supplementing $D_3$ (0, 360 and 720 IU/kg) to a vitamin $D_3$-dificient diet. Atencio *et al*., (2005) reported that hens fed the highest and the lowest levels of 25-OH-$D_3$ and $D_3$ had the highest and the lowest hatchability and the lowest and highest embryo mortality, respectively. Atencio *et al*., (2006) found that hens fed high $D_3$ levels in the diet had higher hatchability and lower embryo mortality than hens fed low $D_3$ levels. However, Abdulrahim *et al*., (1977) reported low hatchability and carry- over of vit. $D_3$ activity from eggs of hens fed 1,2 5-$(OH)_2$-$D_3$ or lα-OH-$D_3$ only. Henry and Norman, (1978) fed hens 1,25-$(OH)_2$-$D_3$ as their sole source of vit. $D_3$, they found that embryos failed to hatch. But when hens receive a combination of 1,25-$(OH)_2$-$D_3$ and 24,25-$(OH)_2$-$D_3$ the percentage of hatchability was equivalent to that with hens given cholecalciferol. Narbaitz *et al*. (1987) reported that when laying hens were fed 1,25-$(OH)_2$-$D_3$ for 5 weeks, they laid eggs that showed decreased hatchability. Bethke *et al*., (1936); Griminger, (1966) and Edwareds *et al*., (1995) in experiments conducted with the progeny of laying hens. In their experiments the authors also observed improvements in body weight of chicks hatched from hens fed high levels of vitamin $D_3$. Atencio *et al*., (2005) indicated that the level of vitamin $D_3$ in the maternal diet was effective in improving body weight of the progeny.

The present study was planned to investigate the effects of the population, and adding graded cholecalciferol levels (vitamin D3) to the layers diets on reproductive performance at different egg production periods.

## MATERIALS AND METHODS

The present study was carried out at El – Serw Poultry Research Station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt. The present study was aimed to improve reproductive performance of Mamourah and Sinai strains by dietary supplementation of different vitamin $D_3$ levels. The main objectives were to enhance hatchability and fertility percent of M and S strains and to reduce embryonic mortality as well as improvements in body weight of hatched chicks from hens fed high levels of vitamin $D_3$

A total number of 1920 eggs were incubated from two strains of chickens at the 28th, 40th and 52th weeks of age. Eggs were randomly assigned to four treatments according to vitamin $D_3$ supplementation (0, 300, 600 or 1200 IU/kg of ration) for El-Mamourah as well as Sinai strains in each interval as shown in Table (1).

**Table 1: Distribution of hatching eggs on various groups according to dietary cholecalciferol (Vitamin $D_3$) level and strain**

| Strain | Vitamin level, IU/kg diet | | | | Total |
|---|---|---|---|---|---|
| | 0 | 300 | 600 | 1200 | |
| | $VD_0$ | $VD_{300}$ | $VD_{600}$ | $VD_{1200}$ | |
| **Mamourah** | 240 | 240 | 240 | 240 | 960 |
| **Sinai** | 240 | 240 | 240 | 240 | 960 |
| **Total** | 480 | 480 | 480 | 480 | 1920 |

***$VD_0$ = the control level which is 3000 IU vit. D3/kg diet.**

Each experimental group was subdivided into three replicates (80 eggs each) as shown in Table (2).

**Table 2: Design of the experiment and the number of hatching eggs**

| Strain | | Experimental groups | Number of eggs in each replicate | | | | Total |
|---|---|---|---|---|---|---|---|
| | | | $R_1$ | $R_2$ | $R_3$ | | |
| **Mamourah** | = | 4 x | ( 80 + | 80 + | 80 ) | = | 960 |
| **Sinai** | = | 4 x | ( 80 + | 80 + | 80 ) | = | 960 |
| **Total** | | | | | | = | 1920 |

**Measurements and Observations :**

**1.Fertility percentage:**

It was calculated in the 7th day of incubation by light candling test as follows :

$$\text{Fertility \%} = \frac{\text{Number of fertile eggs}}{\text{Number of total eggs}} \times 100$$

**2.Egg weight loss, Embryonic mortality and Hatchability:**

**a-** Incubated eggs were weighted at 0 and 18 days of incubation to 0.1 gram on an electronic balance. Egg weight loss percentage was individually at each incubation interval and as a total egg weight loss during the incubation period.

**b-** Embryonic mortality was classified according to the time of incubation at which it occurred into the following categories :

| category | Time of occurrence from incubation period ( days) |
|---|---|
| $D_1$ | 0 - 7 |
| $D_2$ | 7 -14 |
| $D_3$ | 14 – 21 |

Where:

$D_1$ = dead embryos at the end of the first week of incubation.

$D_2$ = dead embryos at the end of the second week of incubation.

$D_3$ = dead embryos at the end of the third week of incubation (unhatched eggs, piped live, piped dead and cull chicks).

Total embryonic mortality was estimated as a percentage of $D_{1+2+3}$ embryos to fertile eggs :

$$\text{Total embryonic mortality \%} = \frac{\text{Number of } D_{1+2+3} \text{ embryos}}{\text{Number of fertile eggs}} \times 100$$

**c-** Hatchability percentage was calculated as a number of healthy chicks hatched as a percentage of fertile eggs :

$$\text{Hatchability \%} = \frac{\text{Number of healthy chicks}}{\text{Number of fertile eggs}} \times 100$$

**d-** Chicks hatch from each treatment were individually weighted to the nearest 0.1 gram at the 1st day from hatch.

**Statistical Analysis:**

The statistical analysis was conducted using SPSS® (2004) software program. GLM procedure of SPSS was used. Mean differences were tasted by Duncan's New Multiple Range Test (Duncan, 1955). When significant P value was obtained. All percentage data were transformed to their corresponding arcsin angles according to Snedecor and Cochran (1981) before analysis.

For the all traits hatching at 28, 40 and 52 weeks of age, analysis of variance was based on a factorial experimental of 4 × 2 × 3 according to the following model :

$$Y_{ijkm} = \mu + L_i + S_j + I_K + (LS)_{ij} + (LI)_{ik} + (SI)_{jk} + (LSI)_{ijK} + e_{ijkm}$$

where :

$Y_{ijk}$ :the observation on the $ijk^{th}$ individual;

$\mu$ :the overall mean common to all observations;

$L_i$ the effect of $i^{th}$ vitamin $D_3$ level ( i = 1,2.3.4 );

$S_j$ the effect of $j^{th}$ strain ( j =1,2 );

$I_K$ **:**the effect of $k^{th}$ age interval ( k = 1,2,3 );

$(LS)_{ij}$ :the effect of interaction $i^{th}$ vitamin $D_3$ level by $j^{th}$ strains;

$(LI)_{ik}$ :the effect of interaction $i^{th}$ vitamin $D_3$ level by $k^{th}$ age intervals;

$(SI)_{jk}$ :the effect of interaction $j^{th}$ strain by $k^{th}$ age intervals;

$(LSI)_{ijK}$ :the effect of interaction $i^{th}$ vitamin $D_3$ level by $j^{th}$ strain by $k^{th}$ age intervals;

$e_{ijkm}$ :the random error.

## RESULTS AND DISCUSSION

**1. Egg weight loss percentage :**

. Data presented in (Table 3) shows that egg weight loss (%) as affected by strains, maternal dietary vitamin $D_3$ supplementation at three different age intervals (wks) during the laying cycle and their interactions as well as analysis of variance. Generally, Mamourah eggs had significant ($p<0.01$) heavier egg weight loss percentage (11.51 %) during the whole period of incubation (0–18 days) than those of Sinai ones (11.09 %). These results agree with the finding of Whitehead *et al*., (1985) and Soliman *et al*., (2000) who found that strain of pullets affect egg weight loss percent.

The results indicated that increasing the cholecalciferol content in feed lead to increase rate of egg weight loss during the whole period of incubation (0–18 days). The importance of vitamin D to hatchability is due to its role in calcium metabolism and transfer of calcium from the shell to the embryo as reported by Landauer, (1967). Various concentrations of vitamin $D_3$ in maternal diets effected eggshell conductance (EC) and increased egg weight loss when compared with the control. One of the basic biological functions of the eggshell of the domestic fowl is to provide an incubation environment in which a new chick can develop and to allow for adequate movement of water vapour and respirator gases (eggshell conductance, EC)(Tullett, 1978). Results obtained showed a reduction in egg weight loss percentage by advancing in age interval. In both strain the maximum rate for egg weight loss percent was attained in the early laying interval followed by middle and then the late laying cycle.

**2-Fertility percentage :**

Data in (Table 4) showed that egg fertility in M strain was significant ($p<0.001$) higher (96.01 %) than that (93.62 %) of S ones.

The results showed that egg fertility from hens fed diets varying in vitamin $D_3$ supplementation (300, 600 or 1200 IU/kg feed), regardlessof the strain or age interval, was not affected by treatment as compared to the control. These results are inagreement with those of Menge *et al*., (1977) and Soares *et al*., (1979) who reported that dietary vitamin $D_3$ in excess of established requirements had no statistically significant effect on fertility (%).

It was obvious that fertility (%) decreased in eggs laid early laying cycle (95.55 %), thereafter, it slightly increased reached its maximum value in eggs laid middle laying cycle (95.94 %) then significantly deceased in eggs laid late laying cycle (92.97 %).

**3- Hatchability percentage :**

Data on hatchability (%) relative to both all set and fertile eggs in M and S laying pullets fed experimental diets during different age intervals (wks) as well as analysis of variance are shown in (Tables 5 and 6), respectively. Irrespective of the intervals and maternal dietary vitamin $D_3$ levels, the hatchability (%) relative to both all set and fertile eggs with M was significantly ($P<0.001$) better than that of S by about 5.6 and 3 %, respectively. Similar results were obtained by Arad and Marder, (1982) who observed that hatchability of chicken eggs were higher in White Leghorn than in Sinai.

T3

T4

T5

t6

The hatchability (%) relative to both all set and fertile eggs of the groups which had supplementary vitamin $D_3$ levels of 300, 600 or 1200 IU/kg feed significantly surpassed than those of the control group by about (5 and 5.4 %), (10.4 and 9.7 %) and (11.1 and 10.5 %), respectively.

These results are inagreement with Bethke *et al*., (1936a,b); Couch *et al*., (1947); Abdulraim *et al*., (1979) and Atencio *et al*., (2006) who observed an increase in hatchability by feeding hens increasing levels of $D_3$ in the diet. It was noticed that hatchability (%) of all set or fertile eggs decreased in eggs laid early in a cycle (80.95 and 84.70 %), thereafter, it significantly increased reached its maximum value in eggs laid middle laying cycle (85.37 and 88.90 %) then hatchability (%) of all set eggs significantly decreased in eggs laid late laying cycle (82.03 %), whereas, hatchability (%) of fertile eggs slightly decreased in eggs laid in the same interval (88.28 %). It appears that within each strain hens, the highest rate of hatchability either relative to all set or fertile eggs was achieved during the middle laying cycle. This trend was observed in all the different vitamin $D_3$ levels, hatchability (%).

**4- Embryonic mortality :**

Means of the percentages of the whole embryonic mortality $D_{(1+2+3)}$ as well as analysis of variance are given in (Table 7).

There were highly significant differences ($P<0.001$) in $D_{(1+2+3)}$ due to the effect of strain. Switching the dietary supplement from o to 1200 IU of vitamin $D_3$/kg feed resulted in a significant decrease in whole embryonic mortality. These are inagreement with Bethke *et al.*, (1936 a,b); Couch *et al*., (1947); Abulrahim *et al*., (1979) and Atencio *et al*., (2005,2006) who observed a reduction in embryonic mortality by feeding hens increasing levels of vitamin $D_3$ in the diet. From results obtained it could be observed that the highest and the lowest percentage of embryonic mortality in eggs laid early and middle of a laying cycle, respectively. As the hen ages effects on the porosity of the eggshell can be seen, with the pore concentration decreasing over the air space and the equator of the egg but not on the small and of the egg. Pore concentrations on hatching and nonhatching eggs laid early in the cycle are different than the pore concentrations laid late in the laying cycle (Christensen, 1983). It appears that within each strain hens, the lowest rate of embryonic mortality was achieved during the middle laying cycle with all the different vitamin $D_3$ levels.

**5- Absolute and relative (%) chick weights at hatch :**

Data presented in Tables (8 and 9), show the effect of strain, maternal dietary vitamin $D_3$ supplementation, intervals (wks) and their interactions on chick weight at hatch either (gm) or a percentage initial egg weight, as well as analysis of variance . In general, Heavier chick weights at hatch either (gm) or (%) were achieved by M as compared to those obtained by S laying pullets. This may be attributed to Sinai egg is similar than Mamourah ones.

T7

T8

T9

The results of this work indicated that level of vitamin $D_3$ in the maternal diet was effective in improving body weights of the progeny. These results are inagreement with the finding of Bethke *et al*., (1936b), Griminger (1966), Edwards *et al*., (1995) and Atencio et al., (2006) in experiments conducted with the progeny of laying hens. In their experiments the authors also observed improvement in body weight of chicks hatched from hens fed high levels of vitamin $D_3$ .

The results revealed that there were a gradual in chick at hatch either (gm) or percent of egg weight as pullets age. This may be attributed to a gradual increase in egg weight results in a gradual increase in chick at hatch (gm or (%)as pullets age. It has been observed that the conductance of eggshells from late cycle eggs allows smaller fractional water losses than early cycle eggs ( Rahn *et al*., 1981). It appears that within each strain hens, the heaviest chick weight at hatch either (gm) or a percent of initial egg weight was achieved during the late laying cycle. This trend was also observed in all the different vitamin $D_3$ levels.

**6-Economical efficiency (%)** :

Means and standard errors of economic efficiency (%) for the eggs incubated during the laying period as affected by strains, maternal dietary vitamin $D_3$ supplementation are shown in (Table 10)

**Table 10: Economic efficiency (EE %) of the eggs incubated during the whole experimental period as affected by strains, maternal dietary vitamin $D_3$ supplementation, intervals (wks) $\overline{X}$ ±SE**

| Treatment | | Whole experimental period (20-52 wks) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No.(1) | Cost (LE)* | | | No.(2) | Total revenue, LE | Net revenue, LE | EE (%) |
| | | | Total eggs set | Incubation of total eggs set | Total | | | | $\overline{X}$ ±SE |
| Strain | Mamourah | 2880 | 1008.00 | 345.6 | 1353.6 | 2449 | 2081.65 | 728.05 | 53.79±1.08$^{A}$ |
| | Sinai | 2880 | 864.00 | 345.6 | 1209.6 | 2319 | 1739.25 | 529.65 | 43.79±1.08$^{B}$ |
| Vitamin D3 level, IU/kg diet | VD0 | 1440 | 468.00 | 172.8 | 640.8 | 1118 | 896.70 | 255.9 | 39.56±1.53$^{C}$ |
| | VD300 | 1440 | 468.00 | 172.8 | 640.8 | 1174 | 941.00 | 300.2 | 46.54±1.53$^{B}$ |
| | VD600 | 1440 | 468.00 | 172.8 | 640.8 | 1234 | 988.50 | 347.7 | 54.02±1.53$^{A}$ |
| | VD1200 | 1440 | 468.00 | 172.8 | 640.8 | 1242 | 994.70 | 353.9 | 55.02±1.53$^{A}$ |
| Intervals | Early | 1920 | 624.00 | 230.4 | 854.4 | 1554 | 1245.70 | 391.3 | 45.48±1.33$^{b}$ |
| | Middle | 1920 | 624.00 | 230.4 | 854.4 | 1639 | 1313.75 | 459.35 | 53.44±1.33$^{a}$ |
| | Late | 1920 | 624.00 | 230.4 | 854.4 | 1575 | 1261.45 | 407.05 | 47.44±1.33$^{b}$ |
| Total | | 5760 | 1872 | 691.2 | 2563.2 | 4768 | 3820.9 | 1257.7 | 48.79±0.77 |

***The prices of 1 egg was 0.35 and 0.30 LE for incubation of M and S eggs, respectively.**
**The incubation cost of 1 egg was 0.12 LE (according to the experimental time).**
**The prices of 1 chick was 0.85 and 0.75 LE for hatched of M and S chicks, respectively.**
**Where:- LE = 1 pound Egyptian currency = 100 piaster;0.35 and 0.30 LE (according to price of institute);**
**0.85and 0.75 LE (according to the local market at the experimental time)**

**(1) : Number of total eggs set; (2) : Number of total healthy chicks.**

**Means within each factor within the same column with different superscripts differ significantly (P≤0.05).**

The significantly higher of economic efficiency (%) throughout the experiment was observed in chicks hatched from M eggs than those S ones by about (22.8 %). This improvement of economic efficiency may be due to increase of hatchability of M eggs as well as price of one M chick as compared to S ones. In addition to the previous mentioned discussion, the economic efficiency (%) responded positively to the increasing of levels of vitamin $D_3$ in maternal diets from 300 up to 1200 IU/kg feed and surpassed than those of the control group by about 17.6, 36.6, and 39.1 %, respectively.

**CONCLUSION**

From the previously mentioned results, it could be could concluded that Mamourah hens fed highest vitamin $D_3$ in the diet during middle laying seemed to be adequate to achieve the favorable results and would be economic

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## تأثير استخدام مستويات مختلفة من فيتامين د ٣ في العلائق على الخصوبة ونسبة الفقس في سلالتين من الدجاج المحلى

**معوض محمد خليفه[١]- ترك محمد إبراهيم درة[١] – مرفت عطيه على[١]- عصام فؤاد عبد الحميد[٢] و احمد فرج إبراهيم على[٢]**

**١-قسم إنتاج الدواجن- كلية الزراعة –جامعة المنصورة.**

**٢-معهد بحوث الإنتاج الحيواني –الدقي -الجيزة.**

نم تفريخ عدد ١٩٢٠ بيضه من سلالتين من الدجاج عند عمر ٢٨،٤٠،٥٢ أسبوع ، وقد لقحت الدجاجات صناعيا من سائل منوي طازج وغير مخفف من ديوك كل سلاله عند نفس العمر ، وتم توزيع البيض عشوائيا إلى أربعه مجموعات متساوية تبعا لمستوى أضافه فيتامين د٣ ( صفر ، ٣٠٠ ، ٦٠٠ ، ١٢٠٠ وحده دولية لكل كيلو جرام عليقه) لسلاله المعمورة وكذلك لسلاله السينا. ثم وزعت بيض كل معامله في ثلاثة مكرارات ( ٨٠ / مكرره ).

الهدف من هذة الدراسة هو بحث تأثير إضافة مستويات متدرجة من فيتامين د٣ على الأداء التناسلي في كل سلاله عند فترات إنتاج البيض المختلفة .

ويمكن تلخيص النتائج المتحصل عليها فيما يلي :-

1- كان تأثير السلالة على معدل الفقد في وزن البيض عالي المعنوية، فقد زاد معدل الفقد في وزن البيض في سلاله المعمورة ( 11.51% ) مقارنه بسلاله السينا( 11.09% ) خلال الفترة من ٠ إلى ١٨ يوم من التفريخ.
2- أوضحت النتائج أن زيادة مستوى أضافه فيتامين د٣ في العليقه أدى إلى زيادة معدل الفقد في وزن البيض خلال الفترة من ٠ إلى ١٨ يوم من التفريخ.
3- اوضحت النتائج انخفاض الفقد في وزن البيض مع تقدم العمر.
4- كانت سلاله المعمورة الاعلى معنوية فى الخصوبة ونسبة الفقس عن سلالة السينا.
5- أن الدجاج المغذى في كلا السلالتين على المستوى الأعلى والأقل من فيتامين د٣ كان لها أعلى واقل في نسبه الفقس واقل وأعلى في النفوق الجنينى خلال فتره التفريخ .
6- كان نأ ثير العمر على نسبه الفقس سواء كان من البيض الكلى الموضوع أو من البيض المخصب عالي المعنوية ، فقدا نخفض عند الفترة المبكرة من دورة إنتاج البيض ثم وصل إلى أقصى قيمة لة عند الفترة الوسطي من الدورة ثم انخفضت عند نهاية الدورة.
7- أظهرت النتائج أن الكتاكيت الفاقسة من أضافه مستويات مختلفة من فيتامين د٣ في عليقه الأمهات كان لها تأثير فعال في تحسين الوزن المطلق والنسبي في الأبناء.
8- لوحظ أن الكفاءة الاقتصادية أعلى في بيض المعمورة عن بيض السينا بحوالى (22.8%) وهذة التحسن ناتج عن زيادة نسبة الفقس في بيض المعمورة بالإضافة سعر الكتكوت الواحد مقارنة بسلالة السينا بالإضافة الى ما سبق إلى استجابة الكفاءة الاقتصادية مع زيادة مستويات فيتامين د٣ بالعليقة من ٣٠٠ إلى ١٢٠٠ لكل كيلو جرام علف بحوالى 17.6 ، 36.6 ، 39.1 % على الترتيب .