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SOME FACTORS AFFECTING FERTILITY AND HATCHABILITY OF OSTRICH EGGS

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ABSTRACT: ***The present study was carried out in the Ostrich Research Farm, Department of Poultry Production, Faculty of Agriculture at Shibin El-Kom, Minufiya University, in order to study some productive traits in ostriches including egg production, fertility, hatchability, egg weight loss during incubation, body weight growth rate, egg quality and development of body temperature regulation in relation to the first three consecutive breeding seasons.***

A total number of 10 birds of mature black neck bred ostriches (3 males and 7 females) and 57 chicks at hatch were used in the present study, in the first breeding seasons for three consecutive breeding seasons.

The results were summarized as follows :

1. Fertility percentage of ostrich eggs :

2.1. The first breeding season had lower percentage of fertility (67.5 %) as compared to the fertility percentage of the second breeding season (89.1 %).

2.2. The fertility percentage averaged 71.3 % for all egg set (366 eggs) from the three consecutive breeding season.

2. Hatchability percentage of ostrich eggs :

2.1. The hatchability percentages were 62.7, 70.1 and 46.6 % from total eggs set and 92.9, 78.7 and 88.9 % from firtile eggs in the first, second and third breeding seasons, respectively.

32.2. The differences in hatchability percentages either calculated from total eggs set (ranged from 46.6 to 70.1 %) or from firtile eggs (ranged from 78.7 to 92.9 %) were associated with the breeding seasons.

3. Egg weight loss during incubation :

3.1. The average percentages of egg weight loss ere 3.4, 2.8, 2.5, 2.3, 2.1, 13.1 and 14.3 % in the first, second, third, fourth, fifth week, 35-d and 39-d of incubation, respectively.

3.2. The egg weight loss percentages ranged from 13.4 to 15.3 % at 39-d of incubation with overall mean of 14.3 %.

3.3. The statistical differences in egg weight loss among breeding seasons at all periods of incubation were highly significant ($P \leq 0.01$). The first breeding season had the highest percentages and the third breeding season had the lowest percentages of egg weight loss.

3.4. The correlation coefficients were negative and highly significant ($P \leq 0.01$) between egg weight loss at 39-d of incubation and initial egg weight (-0.6144), egg weight in the first week (-0.2198), egg weight in the second week (-0.1716), egg weight in the third week (-0.5892) and egg weight in the fourth

week of incubation (-0.4536), respectively.
3.5. It was observed that eggs loss less than 10.0 % or more than 20.0 % at 39-d of incubation from their initial weight are less likely to hatch and may not be hatched.
Key words: ***Fertitity, Hatchability, Ostrich.***

INTRODUCTION

Ostrich (Struthio camelus) is a flightless bird and known as the largest living bird. It is native to semi-arid and desert areas of Africa. Ostrich farming has been well developed in South Africa over a century. In the past few decades, ostrich has received increasing attention as meat producing bird. Nowadays, South Africa, USA, Australia, Canada, China, Zimbabwe, Boteswana, Egypt, Tunis, Namibia and Several European countries are attempting to raise significant numbers of ostrich birds (Horbanezuk, 2005).

Today, commercial ostrich farming has become an important component of the livestock industry in several countries with commercial industries in various stages of development. The global growth of ostrich industry bas been through increases in the numbers of birds and ostrich farms. More people are becoming interested in the ostrich in terms of its rearing and in buying its products.

Ostriches are generally regarded as seasonal breeders (Deeming and Ar, 1999). The breeding season affected the hatchability of fertile eggs, chick weight at hatch, hatchability of total eggs, fertility percentage, malpositioned embryos, deformed chicks and assisted chicks during hatching (Ipek and Sahan, 2004).

Comprehensive data are not available now about the importance of normal breeding activities in the production and rearing of ostrich birds. Rapid development for husbandry and breed systems for these birds including incubated eggs technique, hatchability, high mortality of chicks during the first three months of age and microbial contamination of the egg are essential parts of developing appropriate management techniques for these birds. So, there are much need to determine and evaluate productive and reproductive performance of ostrich birds under Egyptian condition.

Therefore, the aim of the present work is to study the effect of breeding seasons on reproductive traits in ostrich birds including, fertility, hatchability, egg weight loss during incubation.

MATERIALS AND METHODS

The present work was carried out in the Ostrich Research Farm, Department of Poultry Production, Faculty of Agriculture at Shibin El-Kom, Minufiya University. The experiment was extended fro Feb., 2004 to Dec. 2007 for three consecutive breeding seasons, in order to study some productive

traits in ostrich including, fertility, hatchability, egg weight loss during incubation.

A total number of 10 birds of mature ostriches (3 males and 7 females) were used in the first breeding season. The age of birds was about 3.0 years for males and 2.5 years for females. Mature birds were maintained on the sand floor in outdoor enclosures (paddocks) surrounded by a wire fencing, providing 320 m^2 per bird (80 m x 40 m). There was a nesting area in the enclosure. Drinking water was available at all times in the enclosure. All birds were subjected to the same managerial and hygienic conditions. During the growing period, hatched chicks were housed in pens for 2 – 3 months of age, and in a shed with a access to a paddock thereafter.

The ostriches were fed 2 Kg / bird per day of a pelleted ostrich breeder ration during the breeding season and forage requirements were supplied with fresh alfalfa. Birds were fed *ad libitum* with 1.5 Kg / bird per day of a pelleted plus dried alfalfa during the off season. Four completed diet were used during the experimental period (Table 1). Diet No. (1) was used for chicks from hatch to two months of age. Diet No. (2) was used for chickens from 2 – 6 months of age. Diet No. (3) was used for birds from 6 – 12 months of age. Diet No. (4) was used for birds more than 12 months of age and for layers during the breeding season.

Table (1) : Composition of the experimental diet

Ingredients	Diets * (%)			
	(1)	(2)	(3)	(4)
Clover hay	39.0	38.0	40.5	39.0
Yellow corn	25.0	27.0	28.5	28.5
Soybean meal (44%)	24.0	22.0	16.5	20.5
Wheat bran	5.0	5.0	7.5	5.0
Limestone	0.5	0.5	0.5	0.5
Premix**	7.5	7.5	6.5	6.5
Total	100.0	100.0	100.0	100.0
Crude protein	20.16	18.13	16.57	17.73
ME (kcal/kg)***	2240	2325	2280	2265

*** Anti/fungal was added to each diet from 400 - 600 g/ton diet.**

**** Starter, standard, standard and breeder premix were added to ration No. 1, 2, 3 and 4, respectively.**

**** Vegetable oil was added to each died from 12 – 16 Liters/ton to achieve the requirements from ME (K cal/kg diet).**

This experiment was carried out to investigate the fertility, hatchability percentages, egg weight loss during incubation and egg quality traits. A total number of 366 ostrich eggs laid in different breeding seasons and months were collected. Each egg was identified with parents age, date and weight at laying. Mean length of incubation period (d), fertility and hatchability percentages, egg weight loss during the first 39th days of incubation and different egg quality traits were determined.

The ostrich layers were minetored by a person between laying hours, in order to, collect the eggs immediately after being laid and were coded. Eggs were dry wiped and weighed. Eggs were disinfected with a suitable disinfection for few seconds then allowed to dry for about 30 minutes. Eggs were stored for a maximum of 10 days at 18ºC and 75 % relative humidity in vertical position until incubation.

During incubation, the incubator was adjusted to 36.5ºC and 25% relative humidiy (RH), while at hatching time, the temperature was adjected to 36.0ºC and 40 % RH. Eggs were set in the incubator with air sac upside and were turned through an angle of 45ºC five times daily during the first 39 days of incubation. Infertile eggs, which were determined by candling on day 14 of incubation using a 150 – watt candling lamp, were removed from the incubator.

Studied traits and measurement :

1. Fertility percentage :

A total number of 366 ostrich eggs was artificially incubated in the three breeding seasons. Fertility was calculated as percentage of fertile eggs relative to the number of all eggs set using the following formula.

$$\text{Fertility (\%)} = \frac{\text{Number of fertile eggs}}{\text{All setting eggs}} \times 100$$

2. Hatchability percentage :

A total number of 223 chicks were hatched from total of incubated eggs. Hatchability (%) was calculated using the following equations :

$$\frac{\text{Number of chicks hatched}}{\text{Number of firtile eggs}}$$

$$\text{Hatchability (\%)} = \frac{\text{Number of chicks hatched}}{\text{Number of firtile eggs}} \times 100$$

$$\text{Hatchability (\%)} = \frac{\text{Number of chicks hatched}}{\text{All setting eggs}} \times 100$$

3. Egg weight loss during incubation :

A total of 55 incubated eggs were used. The initial egg weight of fresh eggs was determined before incubation to the nearest gram. Then the eggs were weighted individually each week for five weeks during the incubation period. The final egg weight was determined on day 39 of incubation, in order to determine the percentage of egg weight loss on day 39 of incubation using the following equation (Deeming, 1995):

$$\text{Egg weight loss (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where = W_1 = intial egg weight and w_2 = egg weight on day 39 of incubation.

4. Statistical analysis :

Data of the present study were statistically analyzed by ANOVA of factorial experiment using SPSS (1999) computer program as given in the following one/way analysis of variance model with breeding season as main effect factor was used as follows:

$$Yij = U + Bi + eij$$

Where :
Yij = The observation on the j^{th} bird in the i^{th} breeding season.
U = The overall mean
Bi = The effect due to the i^{th} breeding season.
Eij = The random error

The percentages were transformed to their arc-sin values before analysis of variance. Also, the significant differences among the averages were tested using Dancan's multiple range test (Duncan, 1955).

Simple correlation coefficients between all possible traits were calculated according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

1. Fertility of ostrich eggs :

Table (2) and Fig. (1) show the results of incubation outcome on 366 ostrich eggs in relation to the first three consecutive breeding seasons. The results revealed that the first breeding season had lower percentage of fertility (67.5 %) as compared to the fertility percentage of the second breeding season (89.1 %). It could be due to that young females tend to mature earlier than males in the first breeding season. But, in the third breeding season, the fertility percentage was the lowest (52.4 %) because the ostrich layers were transferred from old farm at Tuhk-Tampisha to new farm in Faculty of Agric. At Shibin El-Kom. The fertility percentage averaged 71.3% for all eggs (366 egg) from the three consecutive breeding seasons.

Table (2) : Fertility and hatchability percentages of ostrich eggs in relation to the first three consecutive breeding seasons.

Trait	Breeding seasons			Total average
	First	Second	Third	
Total eggs set	126	137	103	366
Fertile eggs	85	122	54	261
Fertility (%)	67.5	89.1	52.4*	71.3
Hatched chicks	79	96	48	223
Hatchability (%)1	62.7	70.1	46.6*	60.9
Hatchability (%) 2	92.9	78.7	88.9	85.4

1. Hatchability (%) from all eggs set.
2. Hatchability (%) from fertile eggs.
* Fertility and hatchability percentages were lower than the first and second breeding seasons because the ostrich layers were transferred from old Farm at Tuhk-Tampisha to new Farm in Faculty of Agric. At Shibin El-Kom.

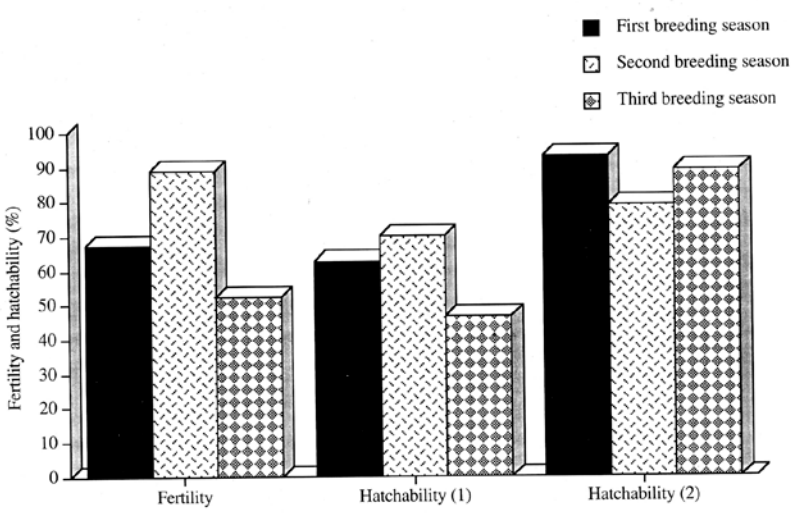

Fig.(1): Fertility and hatchability (1- from total eggs and 2- from fertile eggs) in relation to different breeding seasons.

According to Gowe *et al*. (1993), egg fertility is, generally, considered as a trait of both parents and their ability to interact and produce a viable zygote. After egg production, fertility of ostrich eggs is the next most limiting factor to ostrich chick production (Bunter, 2002), where fertility of ostriches is a very important measure of their reproductive efficiency (Malecki *et al*., 2004).

The average percentage of fertility (70.3 %) in the present study (Table 6) was within the range reported by many authers. Mellett (1993) found that infertility eggs were about 30.0 % for eggs in South Africa. In Zambia, infertility eggs ranged from 30.8 % to 33.1 % (Deeming and Ayres, 1995). In addition, 580 eggs of incubated eggs (866 eggs) were fertile, resulting in an overall fertility 68.1 %, as reported by More (1996). Who added that time of egg laying in the season, duration of egg storage prior to incubation and egg weight at the start of incubation were unconditionally associated with fertility.

However, the variation observed in the fertility percentages in the present study between the first and second breeding seasons (67.5 Vs 89.1 %, respectively) was attributed to the sexual maturity of the birds, where females of ostrich tend to mature earlier (from 2.0 to 2.5 years) than males (about 3 years) causing a synchronization problems in which infertile eggs are laid at the beginning of the season (Gonzales, 1992). Also, infertility may be caused by one or more of factors such as genetic factors, male to female ratio, breeding behaviour, nutrition, health, age of birds and climatic conditions (Deeming, 1995 and Badley, 1997). On the other hand, Zoccarato *et al*. (2004) showed that the fertility percentage of ostrich eggs was 70.0% with a peak 74.0 % and the fertility of all eggs was unaffected by laying seasons and months of laying.

2. Hatchability of ostrich eggs :

As given in Table (2) and Fig. (1), the hatchability percentages were 62.7, 70, 1 and 46.6 % from the total eggs set and 92.9, 78.7 and 88.9 % from the fertile eggs in the first, second and third breeding seasons, respectively. The observed values of hatchability percentages were higher than the range reported by many authers. Deeming (1996) and More (1996) found that the hatchability percentages of total eggs set were ranged from less than 30.0 % to approximately 60.0 %. In addition, hatchability percentage of ostrich eggs in Australia and England is reported to be less than 50.0 %, while, it ranged from 35.0 to 70.0 % in South Africa (Horbanczuk and Sales, 1998). The maximum value for hatchability of fertile eggs is around 70.0 % (Deeming and Ar, 1999).

The present study revealed that there were differences in hatchability percentages associated with the breeding season either calculated from total eggs set (ranged from 46.6 to 70.1 %) or from fertile eggs (ranged from 78.7 to 92.9 %). Opposite results were reported by More *et al*. (1994) who observed that hatchability percentage has not been found to decline with breeding

season. In addition, Zoccarato *et al*. (2004) showed that the hatchability percentage of all eggs was 62.0 % with a peak of 72.0 %, while the hatchability of fertile eggs was more than 90.0 %. They also found that the hatchability percentage of all eggs, as well as, fertile eggs was unaffected by breeding seasons and months of laying.

Successful of artificial incubation, as measured by maximizing hatchability percentage of fertile eggs, depends on many factors. Some of these factors are hen age, breeding season, laying month effect, sex ratio effect, egg characteristics and pre-incubation storage period (Deeming, 1996 and Badley, 1997).

3 . Egg weight loss during incubation :

Least square means (LSM ± S.E.) of egg weight loss at different periods (7, 14, 21, 28, 35 and 39.d) during incubation of ostrich eggs for three consecutive breeding seasons are given in Table (3). The present results revealed that average percentages of egg weight loss were 3.4, 2.8, 2.5, 2.3, 2.1, 13.1 and 14.3 % in the first, second, third, fourth, fifth week, 35-d and 39-d of incubation. It was clear that the first week of incubation had the highest percentage of egg weight loss, then the percentages decreased gradually to reach the lowest percentage at 39 – d of incubation. The egg weight loss percentages ranged from 13.4 to 15.3 % at 39 – d of incubation with overall mean of 14.3 %.

These results are similar to the results reported by some investigators. It ranges from 12.0 – 17.0 % of initial egg weight from setting to 38 – d of incubation (Wilson, 1996), 12.0 to 15.0 % (More, 1996), 13.3 % (Brown *et al*., 1996), 14.1 % (Rizzi *et al*., 2002), 11.8% (Sahan, 2003) and 12.14 to 12.66 % (Hassan *et al*., 2004).

In addition, the statistical differences in egg weight loss among breeding seasons at all periods of incubation were significant ($P \leq 0.05$) or highly significant ($P \leq 0.01$). The first breeding season had the highest percentage and the third breeding season had the lowest percentages of egg weight loss (Table 4).

In this respect, Madzingira *et al.,* (2000) found that eggs laid from May to August tended to lose more weight than those laid from September to November. They also found that laying month and the number of day hatching significantly ($P \leq 0.05$) affected the weight loss. Accordingly, it is necessary to adjust the temperature and relative humidity of the operator incubators.

Table 3

Table (4) : Analysis of variance of egg weight loss of ostrich eggs at different periods of incubation.

Periods (WK)	Between seasons		Within seasons	
	d.f.	M.S	d.f	M.S
EWS-1	2	659707**	352	1346.1
EWS-2	2	8973.2**	352	2118.3
EWS-3	2	3903.3**	352	642.2
EWS-4	2	73547.1*	352	20329.7
EWS-5	2	724767.5*	352	20677.4
EWS-6	2	928514.8**	352	97638.5

*** Significant ($P \leq 0.05$).**

**** Highly significant ($P \leq 0.01$).**

EWS-1, 2, 3, 4, 5 and 6 = Egg weight loss in the 1st, 2nd, 3rd, 4th, 5th week and 39-d of incubation, respectively

4. Correlation coefficients :

The correlation coefficients between egg weight at different periods of incubation (initial egg weight, egg weight in the 1^{st}, 2^{nd}, 3^{rd} and 4^{th} week of incubation) and egg weight loss at different periods of incubation (egg weight loss in 1^{st}, 2^{nd}, 3^{rd}, 4^{th} , 5^{th} week and 39 – d of incubation) are given in Table (5).

The present results revealed that significant ($P \leq 0.05$) or highly signidicant ($P \leq 0.01$) negative correlation coefficients among egg weight and egg weight loss during different periods of incubation. The correlation coefficients were negative and highly significant ($P \leq 0.01$) between egg weight loss at 39 – d of incubation and initial egg weight (-0.6144), egg weight in the first (-0.2198**), egg weight in the second (- 0.1716**), egg weight in the third (-0.5892**) and egg weight in the fourth week of incubation (-0.4536**), respectively (Table 5).**

The present results are similar to the findings reported by Hassan *et al*., (2005). They found a negative correlation (-0.28) between egg weight at lay and egg weight loss at 38 – d of incubation.

It was observed also that eggs loss less than 10.0 % or more than 20.0 % at 39 – d of incubation from their initial weight are less likely to hatch. These observations were similar to the results reported by Harbanezuk and Sales (1998) and Ali (2004).

Table (5) : Correlation coefficients between ostrich egg weight and egg weight loss at different periods of incubation

EW loss at	Egg weight at different periods of incubation				
	EW0	EW-1	EW-2	EW-3	EW-4
EWS-1	-0.1462*	-0.1783**	-0.1369*	-0.1251*	-0.1406*
EWS-2	-0.1332*	-0.2341**	-0.3162**	-0.1253*	-0.1402*
EWS-3	-0.1168	-0.1369*	-0.5819**	-0.1301*	-0.1826**
EWS-4	-0.1376*	-0.1038	0.1023	-0.1495*	-0.9814**
EWS-5	-0.1005	-0.1240*	-0.1638	-0.1292*	-0.8916**
EWS-6	-0.6144**	-0.2198**	-0.1716**	-0.5872**	-0.4536**

Where :

EW0 = Intial egg weight, EW-1, 2, 3, 4 = Egg weight in the 1^{st}, 2^{nd}, 3^{rd} and 4^{th} weeks of incubation, respectively.

EWS-1, 2, 3, 4, 5 and 6 = Egg weight loss in the 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, 5^{th} week, and 39 – d of incubation, respectively.

*** Significant ($P \leq 0.05$).**

**** Highly significant ($P \leq 0.01$).**

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بعض العوامل المؤثرة على نسبة الخصوبة والفقس لبيض النعام

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الملخص العربي

تم إجراء هذه الدراسة بمزرعة أبحاث النعام ، قسم إنتاج الدواجن ، كلية الزراعة بشبين الكوم – جامعة المنوفية بهدف دراسة بعض الصفات الإنتاجية في النعام وتشمل إنتاج البيض ، الخصوبة ، الفقس ، الفقد في وزن البيضة أثناء التفريخ ، وزن الجسم ، معدل النمو، صفات جودة البيضة وتنظيم درجة حرارة الجسم وعلاقتها بالثلاثة مواسم الأولي للتربية .

استخدم في هذه الدراسة عشرة طيور بالغة من نوع النعام الأسود الرقبة (٣ ذكور + ٧ إناث) وعدد ٥٧ كتكوت عند الفقس في موسم التربية الأول ولمدة ثلاثة مواسم متتالية .

ولخصت النتائج كما يلي :

١- نسبة الخصوبة في بيض النعام :

١-١- حقق موسم التربية الأول أقل نسبة خصوبة (٦٧.٥ %) بالمقارنة بنسبة الخصوبة في موسم التربية الثاني .

١-٢- كان متوسط نسبة الخصوبة ٧١.٣ % من إجمالي عدد البيض في المفرخ (٣٦٦ بيضة) في مواسم التربية الثلاث الأولى المتتالية .

٢- نسبة الفقس في بيض النعام :

٢-١- كانت نسب الفقس ٦٢.٧ % ، ٧٠.١ % ، ٤٦.٦ % من إجمالي عدد البيض بالمفرخ، وكانت ٩٢.٩ % ، ٧٨.٧ % ، ٨٨.٩ % من إجمالي البيض المخصب في موسم التربية الأول، الثاني ، والثالث على التوالي .

٢-٢- كانت الاختلافات في نسب الفقس سواء المحسوبة من البيض الكلي (تتراوح من ٤٦.٦ – ٧٠.١ %) أو المحسوبة من البيض المخصب (تتراوح من ٧٨.٧ – ٩٢.٩ %) مرتبطة بمواسم التربية .

٣ – الفقد في وزن البيضة خلال التفريخ :

٣ – ١ – كان متوسط نسبة الفقد من وزن البيضة هو ٣ر٤ ، ٢ر٨ ، ٢ر٥ ، ٢ر٣ ، ٢ر١ ، ١٣ر١ ، ١٤ر٣ % في الأسبوع الأول ، الثاني ، الثالث ، الرابع ، الخامس ، والنسبة الكلية عند ٣٥ يوم ، ٣٩ يوم من بداية التفريخ ، علي التوالي .

٣ – ٢ – كانت نسبة الفقد من وزن البيضة تتراوح من ١٣ر٤ – ١٥ر٣ % عند ٣٩ يوم من التفريخ ، وكان المتوسط العام هو ١٤ر٣ % .

٣ – ٣ – كانت الفروق الإحصائية في الفقد من وزن البيضة بين مواسم التربية المختلفة عند كل الأعمار التي درست أثناء التفريخ عالية المعنوية ($P \leq 0.01$) . وحصل موسم التربية الأول علي أعلا نسبة وموسم التربية الثالث علي اقل نسبة من الفقد في وزن البيضة .

٣ – ٤ – كانت معاملات الارتباط سالبة وعالية المعنوية ($P \leq 0.01$) بين الفقد في وزن البيضة عند ٣٩ يوم من التفريخ ووزن البيضة الابتدائي (0.6144-) ، ووزن البيضة في الأسبوع الأول (0.2198-) ، ووزن البيضة في الأسبوع الثاني (0.1716-) ، ووزن البيضة في الأسبوع الثالث (0.5892-) ، ووزن البيضة في الأسبوع الرابع من التفريخ (0.4536-) علي التوالي .

٣ – ٥ – لقد لوحظ أن البيض الذي يفقد اقل من ١٠ % أو أكثر من ٢٠% عند عمر ٣٩ يوم من التفريخ من وزن البيضة الابتدائي يكون اقل في نسبة الفقس وقد لا يفقس .

Table (3) : Lest square means (LSM ± S.E) of egg weight loss at different periods during incubation of ostrich egg for three consecutive breeding season.

Period	Egg weight loss (g) during incubation (LSM ± S.E. and %)							
	First season		Second season		Third season		Total average	
	LSM ± S.E	%	LSM ± S.E	%	LSM ± S.E	%	LSM ± S.E	%
No. of egg	123		133		99		355	
EWO (g)	1356 ± 11.2		1435 ± 10.1		1455 ± 13.6		1455 ± 12.9	
EW loss-1	48.8 ± 3.11	3.6	47.4 ± 2.92	3.3	46.6 ± 4.03	3.2	47.6 ± 3.82	3.4
EW loss-2	42.7 ± 4.05	3.1	40.2 ± 3.87	2.8	37.8 ± 2.76	2.6	40.0 ± 3.52	2.8
EW loss-4	38.0 ± 3.16	2.8	35.9 ± 3.26	2.5	33.5 ± 3.15	2.3	35.1 ± 3.29	2.5
EW loss-4	33.9 ± 4.06	2.5	31.6 ± 3.54	2.2	3.06 ± 2.81	2.1	32.0 ± 3.23	2.3
EW loss-5	27.8 ± 2.81	2.1	30.1 ± 2.94	2.1	29.1 ± 2.87	2.0	29.0 ± 2.48	2.1
TEW loss-6	191.2 ± 12.3	14.1	185.1 ± 11.9	12.9	77.5 ± 13.15	12.2	184.6 ± 12.69	13.1
TEW loss-7	207.5 ± 14.8	15.3	202.3 ± 13.6	14.1	195.0 ± 11.9	13.4	201.6 ± 12.9	14.3

Where :
EWO = Initial egg weight, EW loss. 1, 2, 3, 4 and 5 = Egg weight loss in the 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} weeks of incubation, respectively, TEW loss – 6 = Total egg weight loss at 35-d of incubation and TEW loss-7 = Total egg weight loss at 39 – d of incubation.