Short communication

Productivity of emus (*Dromaius novaehollandiae*) farmed under industrial conditions in Saudi Arabia

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Key words: emus; hatchability; fertility; egg defects; embryonic mortality; Saudi Arabia.

Running title: Productivity of emus in Saudi Arabia.

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Abstract

A study was conducted to record preliminary data on the productivity of emus (*Dromaius novaehollandiae*) in a mixed ratite farm in Central Saudi Arabia. New emus breeders started egg laying at 22 months of age with an average production of six eggs per female in their first season. Older birds had an average of 10 – 13 eggs/female/season. The mean fertility rate of emu eggs ranged between 65.7% and 77.4% over four production seasons while the mean hatchability rate ranged between 52.2% and 73.1% over the same four production seasons. The main causes of emu egg defection were: holes, size abnormality, cracks and excessive dirt. There was an overall embryonic mortality rate of 45.5% of the fertile emu eggs with the majority (66.4%) as late mortality compared to (33.6%) early mortality.

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Introduction

Ostriches (*Struthio camelus*), emus (*Dromaius novaehollandiae*) and rheas (*Rhea americana*) are the most popular species of ratites. Ratites have pure red meat characterized by high protein and lower cholesterol levels compared to chicken and turkey (14). Historically, ostriches were hunted in Africa principally for their feathers. Today, feathers have lost economic significance and the birds are being farmed for their meat, leathers and oil. Emu (*Dromaius novaehollandiae*) farms are not widely spread as the case with ostriches and are confined to a few countries such as Australia, France and the Middle-East especially Palestine, Egypt and recently Saudi Arabia. Beside the classical products of the ratites, emus produce an oil with remarkable pharmacological properties (5).

In this communication, the results of a preliminary study on the productivity and production performances of emus in a mixed ratite farm in Saudi Arabia are presented.

Materials and methods

Farm history: The research was conducted on a ratite farm established in 1997 in Al-Qassim region, Central Saudi Arabia. The breeding stock was composed initially of 400 ostriches and 400 emus imported from France as ready-to-lay breeders (5-6 years old). The male to female ratio for the emus was 1:1 (200 birds of each gender). The original breeding stock was housed in communal pens in the first production season (1998/1999) then transferred to single-couple pens in the following seasons. The stocking density ranged from 80 to 100 birds per communal pen which measured

100 X 200 m^2. However, each of the couple pens which held two birds per pen measured 10 X 30 m^2. All pens were supplied with feeders, drinkers and shaded areas for protection against the extremes of heat during summer. The hatchery section consisted of five incubators and three hatchers (Mayenne Eclosion, St. Jean Sur Mayenne, France). The chick rearing section was composed of 24 rooms of varying sizes ranging from 9 to 32 m^2 each, with outer and shaded exercise area. Each room was supplied with one or more dual purpose air-conditioner. The grower birds were housed in pens of different and varying dimensions ranging from 20 X 30 m^2 to 100 X 200 m^2 and were supplied with the necessary amount of feeders, drinkers and shaded areas. The feed was processed locally on the farm feed plant.

Production Operation: Eggs were collected daily from the pens, labeled with date and pen number on the egg shell and then transferred to the hatchery where they were inspected for incubation suitability. Good, non-defective eggs were cleaned by tissue papers and were fumigated by potassium permanganate and formaldehyde solution mixture for 20 minutes (6). The eggs were then stored in a storage room at 18ºC and 60% to 70% relative humidity for 2 to 6 days. Defective eggs (oversize, undersize, elongated, cracked or too dirty) were discarded because of incubation unsuitability and bio-security hazards. Eggs were fumigated again twelve hours before transfer to the incubator and were preheated to 25ºC. Eggs were incubated at a temperature of 35.5ºC and a relative humidity of 25%. The incubated eggs were assessed for fertility after three weeks of incubation by an infra-red testing apparatus (Emu vision, Minnedosa, Manitoba, Canada). Fertile eggs were returned to the incubator to continue incubation while non-fertile eggs were removed. Eggs were tested at day 49 for embryonic viability, by the same testing apparatus, before being transferred to the hatcher for hatching at a temperature of 35.2ºC and a relative humidity of 33%. All non-hatched eggs were opened to investigate the cause of hatching failure at day 52 of incubation. Hatched chicks were transferred to the rearing section and were i**m**munized at day one against Newcastle and infectious bronchitis via aerosol spraying on the eyes and nostrils (Twinvax-MR®, Schering Plough Animal Health, USA). The second and third vaccinal doses against Newcastle disease were administered subcutaneously using an oil-adjuvant vaccine at days 21 and 90 (Binewvax or Imopest, Merial, Lyon, France).

Production records: Data on egg production, egg condition, fertility and hatchability, number of chicks produced and incidence and causes of embryonic mortality were all recorded over four production seasons (1998/1999 – 2001/2002).

Statistical analysis: The raw data was analyzed as means and percent indices. Differences between means were evaluated by Student's t-test and p (probability) was set at 0.05.

Results

Original (imported) emu breeders had an average egg production of 10 eggs per female in their first season in Saudi Arabia (1998/1999) compared to 13 eggs per female in the second season (1999/2000). The majority (94.3%) of the eggs were laid during November – February period coinciding with the winter months in Saudi Arabia whereas the egg production season extended from September to April which covered the coolest months of the year. The new emu breeders (breeders produced in the farm) started egg laying at 22 months of age with an average egg production of six eggs per female in their first season (2000/2001) ($p<0.05$).

Fertility rates of emu eggs (The number of fertile eggs at candling on the 21st day of incubation divided by the total number of eggs incubated X 100 (%)) are shown in Table I. The mean fertility rate in the first season (1998/1999) was higher (77.4%) than the fertility rate in the subsequent seasons (65.7%, 67.7% and 67.6%) but the differences were not significant (P>0.05).

The overall mean hatchability rate of emu eggs in three seasons (62.7%) was relatively lower than the overall mean fertility rate of emu eggs (69.6%) during four production seasons (1998/1999 – 2001/2002) (Table II).

Fig. 1 shows the number of eggs laid by the original breeders as well as eggs laid by the new breeders as indicators of egg laying persistency by each of the two layer groups. Original emu breeders were more persistent and sustainable in egg laying compared to their descendants which stopped laying after a relatively shorter period. Defective emu eggs throughout four hatching seasons are presented in Table III. As more eggs were laid, the percentage of defective eggs also increased. There were significantly more defective eggs in the last two production seasons than the first two seasons (P=0.001). The different causes of defect in emu eggs are presented in Fig. 2. The main cause of defect was the presence of holes on the egg shell (24.9%) followed by undersized eggs (24%) (eggs smaller than the acceptable size for incubation). Other important causes of defect included dirty shells (19.9%), cracks (14.9%) and oversized eggs (11.8%).

Embryonic mortality in emu eggs is presented in Table IV. There was an overall embryonic mortality of 45.5% of the fertile eggs. The majority of mortality (66.4%) was late occurring during the last two weeks of incubation period compared to early embryonic mortality (33.6%) (occurring during the first four weeks of incubation; p<0.05). Details of the pathology and aetiology of embryonic mortality will be presented separately.

Discussion

The egg production season of emus in Saudi Arabia started in September and ended in March/April. Emus are known to be short-day breeders, most of egg laying occurring during the winter. Malecki *et al*. (9) and Blache *et al.* (2) found that, in emus, plasma concentrations of luteinizing hormone and testosterone levels increased while their plasma prolactin level decreased during short photoperiod days. Since the production season of emus alternates with that of ostriches, the latter being long day breeders, both ratite species can be integrated in the farm in order to maximize the utilization of land, farm capacity and labour (1). The majority of emu chicks were produced in the middle of the production season (January – Mach) which was also the period of high egg laying. The higher percentage of defective emu eggs during the last two seasons (2000/2001 and 2001/2002) compared to the previous seasons could be attributed to the fact that the new breeders, unlike their ancestors which had a significant contribution in the laid eggs, were kept in communal pens. It is possible that eggs laid in communal pens were more prone to damage and soiling compared to eggs laid in couple pens. The higher incidence of holes in the defective emu eggs is attributable to the rocky nature of the farm soil and to the relatively thin emu egg shell. The high tendency for defecation in emus might be a reason for the increased percentage of dirty and faecal-spoiled emu eggs. Too dirty or cracked eggs could be an excellent source of contamination in the incubator while oversized or undersized eggs could not fit properly in the incubator trays and, therefore, might be damaged during automatic turning of the egg trays. Moreover, it is well reported in the literature that as the egg size increases, hatchability decreases due to many factors including difficulties in heat and gas exchanges (3). The more persistency and sustainability in egg laying of emu original breeders compared to their descendants, might be attributed to the full maturity of the reproductive systems of the former (4). The short breeding cycle of emu new breeders has been attributed to the immediate drop in gonadotrophins to levels that are insufficient to support the reproductive hormonal requirements (2).

The drop in fertility rates of emu eggs in the subsequent seasons compared to 1998/1999 season was possibly due to the change in husbandry system. The keeping pattern was changed from the communal system in which the fertility rate is usually higher (11) to the single couple system in the following seasons. However, this advantage of increased fertility should be weighed against the higher incidence of defective eggs (eggs that could not be incubated). It is confirmed, in this study, that emus had higher overall mean fertility rate (69.6%) and lower overall mean hatchability rate (62.7%) despite the fact that emus copulate less frequently (once a week) compared to ostriches (10).

Total embryonic mortality had a mean of 45.5% of the fertile eggs with 66.4% of that considered as late mortality and 33.6 % as early mortality. Similar observations were made in ostriches by Ley *et al.* (8) and Horbanezuk and Sales (6). The high incidence of late embryonic mortality was due to several factors including insufficient water loss during incubation, and suffocation. Smith *et al.* (13) reported that horizontal positioning of eggs for the first 2 – 3 weeks and then vertical positioning for the rest of the incubation period yielded better hatchability with less embryonic mortality. In this farm, vertical positioning was adopted throughout the incubation period because of hatchery specifications. This might have contributed to higher embryonic mortality. Yolk sac infection was also blamed as a cause of late embryonic mortality due to contamination with microbial agents which penetrate the egg shell (3; 7). Pre-incubation of eggs, particularly by the male breeders with subsequent cooling and storage of the pre-incubated eggs, was considered a main cause for early embryonic mortality (12). However, the relatively lower embryonic mortality (26.9%) in the 1999/2000 compared to other seasons was due to the better efficiency of the incubation machines resulted from the installation of a new water chiller while the increased rate of embryonic mortality in the subsequent seasons was attributable to the frequent electricity failures encountered in these production seasons.

The results of this study could be of high importance in the development of emu industry particularly if the main limiting factors such as causes of embryonic mortality and causes of egg defects are carefully researched and necessary preventive measures are taken. Further research to improve both fertility and hatchability of emu eggs is justified.

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Fig. 1. Persistency of emu egg laying.

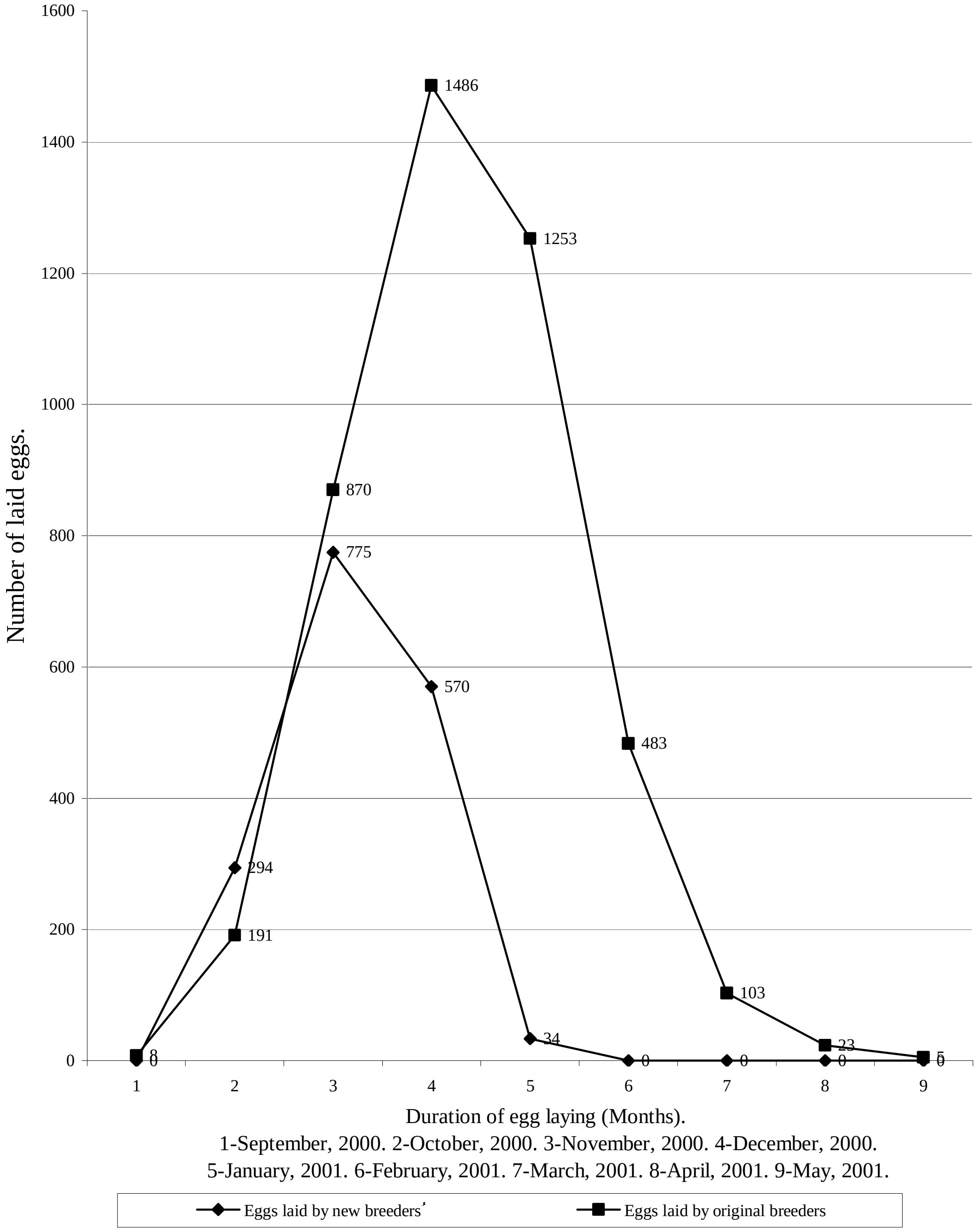

Fig. 2. Causes of emu egg defects.

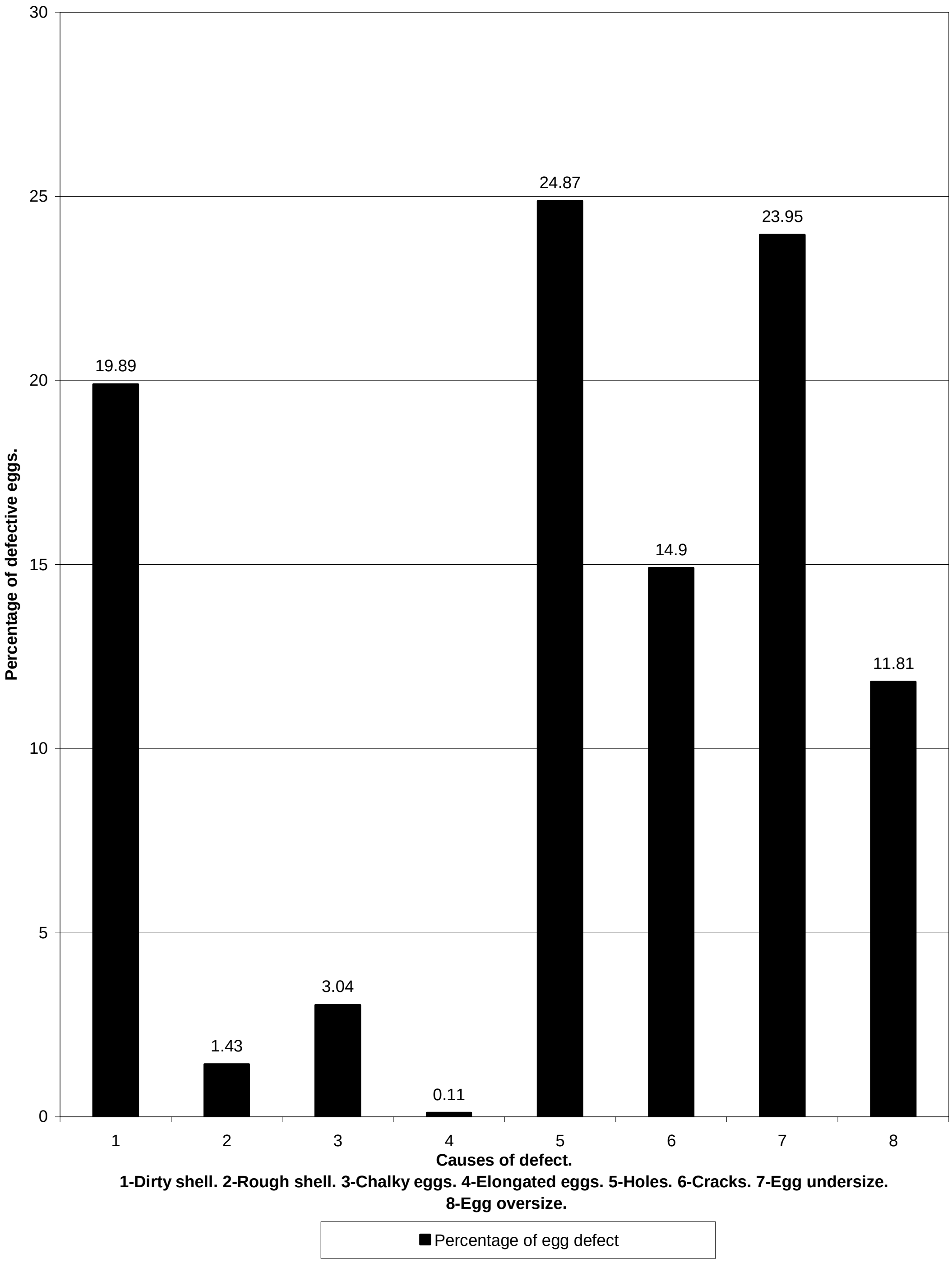

Table I. Fertility rates of emu eggs during four production seasons.

Month	Fertility rates (%)			
	1998/1999	1999/2000	2000/2001	2001/2002
September	No eggs	No eggs	No eggs	No eggs
October	No eggs	No eggs	60.0	61.3
November	58.5	84.0	71.7	68.8
December	91.7	80.7	70.1	71.1
January	93.4	75.2	71.1	72.3
February	91.6	66.1	62.8	63.7
March	71.4	34.9	70.6	68.5
April	57.9	53.3	No eggs	No eggs
Mean (%)	77.4	65.7	67.7	67.6
Overall mean fertility rate (%)	69.6%			

Legend: Fertility rate (%) equals (=): Number of fertile eggs at candling (on 21st day of incubation) divided by total number of incubated eggs (%).

Table II. Hatchability rates of emu eggs during four production seasons.

Month	Hatchability rates (%)			
	1998/1999	1999/2000	2000/2001	2001/2002
October	No eggs	No eggs	67.9	60.3
November	60.5	73.7	55.5	58.7
December	47.9	75.2	64.2	66.6
January	55.3	77.6	60.4	59.3
February	52.9	76.7	60.2	61.8
March	51.3	72.7	71.7	68.1
April	45.5	62.5	No eggs	No eggs
Mean (%)	52.2	73.1	63.3	62.5
Overall mean hatchability rate (%)	62.7 %			

Legend: hatchability rate (%) equals (=): Number of hatched chicks divided by total number of fertile eggs transferred to hatcher machine (%).

Table III. Defective emu eggs (1998/1999 – 2001/2002).

Season	No. of laid eggs	No. of defective eggs	%
1998/1999	2003	96	4.8
1999/2000	2535	46	1.8
2000/2001	6094	632	10.4
2001/2002	9343	1726	18.5

Table IV. Embryonic mortality in emu eggs during four production seasons.

Season	No. of fertile eggs	No. of dead embryos	Early mortality		Late mortality	
			No.	%	No.	%
1998/1999	1476	716 (48.5%)	206	28.9	510	71.1
1999/2000	1635	440 (26.9%)	130	29.7	310	70.3
2000/2001	3042	1357 (44.6%)	521	38.4	836	61.6
2001/2002	3704	1974 (53.3%)	647	32.8	1327	67.2
Total	9857	4487 (45.5%)	1504 (33.6%)		2983 (66.4%)	

Legend:

- Late mortality is mortality occurring during last two weeks of incubation.
- Early mortality is mortality occurring during first four weeks of incubation.