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Performances of emu birds under captive conditions

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Abstract
The present study was conducted to analyse the production performances, egg characters and mortality pattern in emu birds under captive conditions in Tamil Nadu, India during the year 2005-06 to 2012-13. The emu breeders started to lay eggs from 764.1±44.39 days. The production (mean ± SE) of 13.0±2.86, 21.8±3.39, 24.2±2.49, 29.1±13.13, 30.2±11.77, 24.9±10.12, 26.3±7.41 and 25.02±8.11 eggs per hen for 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8thlaying seasons, respectively with the spread of laying period 75.2±10.81, 98.7±8.98, 88.6±10.47, 119.1±12.71, 109.7±14.85, 97.6±11.02, 100.1±11.21 and 103.22±10.76 days were recorded, respectively. The mean ±SE egg weight (g) was 488.98±1.69, 562.23±4.08, 590.85±4.44, 593.12±3.50, 614.43±4.99 and 633.46±3.86, 631.27±3.02 and 632.89±4.65 for 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8thlaying seasons, respectively. In the current study, physical characters of emu eggs were recorded. Mortality pattern in emu chicks, growers and adults birds were also observed in the present study.

Keywords: Emu, *Dromaius novaehollandiae*, Egg, Fatty acids, Mortality

1. Introduction
Emu (*Dromaius novaehollandiae*) is second largest bird of world belonging to order *Ratite* [1]. The Australia's native birds are reared commercially in many parts of the world for their meat, oil, skin and feathers, which are of high economic value [2]. Pattern of egg production for five laying seasons and physical egg qualities of emu were recorded by Kumar *et al.* [3]. But, reproductive performances for long laying seasons were scanty. Emu was adaptable to a wide range of environmental conditions [2]. However, development of emu industry is required knowledge about its disease/deformities under captive conditions.
Hence the present study was carried out to assess the production performances of emu birds consecutively for 8 laying seasons, to analyze the physical characters of emu eggs and to analyze the mortality pattern in emu birds under captive conditions.

2. Materials and Methods
The reproduction performances, physical characters of eggs and mortality pattern in emu birds were conducted at Emu Research Unit, TANUVAS-Regional Research Centre, Pudukkottai, Tamil Nadu, India from the year 2005-06 to 2012-13.

2.1 Reproduction performances
Male and female birds were reared as a separate breeding pair (1000 sq.ft. floor space per breeding pair) under semi intensive system. The birds were offered feed and water *ad libitum.* The emu birds were offered 0 to 14 weeks with starter mash (20% Crude protein, 2700 Kcal Metabolizable energy), 15 to 34 weeks with grower mash (18% Crude protein, 2600 Kcal Metabolizable energy) and 35 weeks and above with breeder mash (20% Crude protein, 2600 Kcal Metabolizable energy). The performances of 10 pair emu breeder were evaluated from 1st to 8th laying seasons consecutively.

2.2 Physical characters of emu eggs
The physical quality of eggs, like specific gravity, shape index, albumin index, yolk index and shell thickness were carried out as per AOAC [4]. This study was conducted in 200 uniform sized eggs collected from 10 hens (20 eggs each hen). The egg content was separated into yolk and albumen then weighed. After mixing separately, samples of yolk and albumen were used for dry matter determination and a large (150 ml) aliquot was taken and freeze dried. The freeze-dried material was used for protein and ash analysis. Fat was determined according to the method described by Folch *et al.* [5].

The eggshells were measured for thickness by a micrometer caliper. The fatty acid composition in the emu egg was determined by Gas chromatography. A fused silica capillary column equipped with an auto sampler and flame ionization detector was used to separate and quantify the fatty acids in this study.

2.3 Mortality pattern emu birds
This study was conducted in 50 emu chicks (0 to 14 weeks), 40 growers (13 to 35 weeks), 30 adult birds aged above 36 weeks. Birds were housed in communal pen upto 1 year. After 1 year, the birds were separated into 1 male 1 female and maintained as separating breeding pairs under semi-intensive system. All the birds were protected against Ranikhet Disease.

2.4 Statistical analysis
Data on reproduction, physical characters of eggs and mortality pattern in emu birds were recorded and analyzed using SPSS computer software 17 [5].

3. Results and Discussion
3.1 Reproduction performances
The egg laying period, egg number and egg weight of the emu breeders are presented in Table 1. The egg laid per hen recorded in the present study was significantly ($p \leq 0.5$) different, but the length of laying period was not different significantly. Egg production observed in this study was higher under Indian agroclimatic condition as compared to study conducted by Rao *et al.* [7] who documented 18.5 eggs/hen/year. But, Szcerbinska *et al.* [8] reported 23eggs/hen/year in the emu breeders. These authors, however, did not specify the age of hens. The variation might be attributed to nutrition, physiological conditions of hen and environment.

Table 1: The mean ± SE of production parameters of emu birds.

Parameters	laying season							
	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eight
Egg laying period(days)	75.2±10.81 NS	98.7±8.98 NS	88.6±10.47 NS	119.1±12.71 NS	109.7±14.85 NS	97.6±11.02 NS	100.1±11.21	103.22±10.76
Egg production/hen (nos.)	13.0±2.86*	21.8±3.39*	24.2±2.49*	29.1±13.13*	30.2±11.77*	24.9±10.12*	26.3±7.41	25.02±8.11
Egg weight(g)	488.98±1.69**	562.23±4.08**	590.85±4.44**	593.12±3.50**	614.43±4.99**	633.46±3.86**	631.27±3.02*	632.89±4.65*

* Means in rows are significant different (P<0.05)
** Means in rows are significant different (P<0.01)

The egg weight was significantly ($p \leq 0.1$) differed between the laying seasons (Table 1). The emu egg weight documented by Minnar and Minnar [2] and Romanoff and Romanoff [9] was 500 to 600 g, 627 g and 711 g respectively without mentioning the laying season. From this study, considerable variation in egg weights was observed between eggs laid by the same hen and also between different hens. The variation in the egg weight might be due to genetic character of emu birds [7].

According to Szcerbinska *et al.* [8], as bird's age advances, egg production, laying period and egg weight increased in emu breeders under captive conditions. The observation made in this study was not agreed with Szcerbinska *et al.* [8]. In this study, egg weight increased as age of the emu bird advances, but egg number increased upto 5 laying year and decreased in the 6th, 7th and 8th laying year. The available literature did not reveal any information on egg production, laying period and egg weight of emu breeders consecutively for 8 laying seasons.

The emu breeders (mean ± SE) were started to lay eggs from 764.1±44.39 days and it was in agreement with Minnar and Minnar [2]. Rao *et al.* [7] reported that emu hens attained sexual maturity at 1278 days of age. The age at which emus come into production varied with individual birds and the level of nutrition [2].

In this study, emu breeders started to lay eggs in the September month and ended in April month (Table 2) which covered the coolest month of the year. It was in agreement with Malecki *et al.* [10] who reported that emu breeders laid eggs in winter months between October to April. But, 91.76 per cent of the eggs were laid during October to February months which coinciding with the winter months in India. In current study, highest number of eggs were laid during December months (25.24%) and lowest were during April (1.08%) month. Rao *et al.* [7] recorded highest number egg production during the month of November and laying period between September to March in emu breeders under India climatic conditions. According to Blache *et al.* [11] and Sharp *et al.* [12], photoperiod was the main controlling factor in the timing of the breeding season. Dissipation of photo refractoriness by short days increased secretion of gonadotropins to levels that were sufficient to support full reproductive conditions in the emu, resulting in the initiation of breading [10]. Malecki and Martin [13] found that, plasma concentration of luteinizing hormone and testosterone levels increased while their plasma prolactin level decreased during short day period.

Table 2: Monthwise egg production in emu birds

Month	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	Total	Percentage
September	0	0	2	10	3	3	7	1	26	2.82
October	5	9	11	55	26	7	26	12	151	16.36
November	8	26	26	46	40	3	36	21	206	22.32
December	4	28	27	37	41	20	30	46	233	25.24
January	9	22	4	30	28	22	24	24	163	17.66
February	5	13	0	17	5	15	20	19	94	10.18
March	0	0	0	9	0	9	8	14	40	4.33
April	0		0	0	0	3	0	7	10	1.08
Total	31	98	70	204	143	82	151	144	923	100

The eggs were laid at 3days interval (58.01%), followed by 21.78%, 8.45% 5.53%, 3.12%, 1.21%, 1.20 and 0.7% with an interval of 4 days, 5 days, 2 days, 6 days, 8-12 days, 13-17 days and 7 days respectively. Almost similar results were documented by Malecki and Martin [14]; Rao *et al.* [7].

According to Minnar and Minnar, [2] emu breeders laid their eggs during the late evening and early morning. The present study also revealed that highest number of eggs of 38.65% was laid during 6 to 7 PM, followed by 28.04%, 14.77%, 6.21%, 4.36%, 4.35%, 1.97% and 1.65% at 7 to 8 PM, 5 to 6 PM, 8 to 9 PM, 4 to 5 PM, 5 to 6 AM, 4 to 5 AM and 3 to 4 PM, respectively. But in the present study, only 6.33% eggs were laid during the morning hours.

3.2 Physical characters of emu eggs

The egg quality studies are presented in Table 3. Majewska [15] observed lesser shape index values (65.8) and Rao *et al.* [16] reported almost similar values (68.40) compared with this study. The emu egg shell thickness is in agreement with Tyler and Simkiss [17]; Rao *et al*. [7]. It was much higher than chicken (0.34 mm) as reported by Simeonova *et al*. [18] and much lower than ostrich (2.1 mm). The albumin index was almost similar to that of avian species but lower than duck (0.114) as documented by Sharma *et al.,* [19]. The albumin index observed in this study was lower than that documented by Jales [1] and Rao *et al.* [7] in emu eggs. The yolk index was 0.31± 0.01 and it was in agreement with Jales [1]. Yolk index of emu eggs was lower that of chicken (0.39) and duck (0.43) as reported by Das *et al*. [20].

Table 3: The mean ± SE of internal qualities of emu eggs.

Parameters	Mean	Range
Specific gravity	1.12±0.01	1.09 to 1.15
Shape index	68.24±0.63	64.40 to 72.20
Albumin index	0.07±0.01	0.04 to 0.10
Yolk index	0.31±0.01	0.28 to 0.33
Shell thickness (mm)	1.14±0.01	1.07 to 1.16

The mean ± SE emu egg fatty acid compositions are presented in Table 4. Higher value of oleic acid and palmitic acid were recorded in this study. The mean palmitic acid, oleic acid and arachidonic acid were higher than that of chicken egg as reported by Beynen [21]. But, similar value of palmitoleic acid and lower stearic acid, linoleic acid, linolenic acid and docosahexaenoic acid were recorded in this study compared to chicken egg as documented by Beynen [21].

Table 4: The mean ± SE of emu egg fatty acid profile.

Fatty acids		Mean	Range
C14:0	Myristic acid	0.12±0.02	0.00 to 0.20
C16:0	Palmitic acid	27.75±0.39	25.43 to 30.15
C16:1	Palmitooleic acid	2.92±0.20	2.30 to 4.23
C18:0	Stearic acid	5.59±0.19	4.30 to 6.26
C18:1	Oleic acid	56.00±0.79	51.12 to 59.96
C18:2	Linoleic acid	4.22±0.17	3.40 to 5.18
C18:3	Linolenic acid	0.22±0.07	0.00 to 0.70
C20:4	Arachidonic acid	2.59±0.30	1.60 to 4.59
EPA	Eicosapentaenoic	0.35±0.05	0.20 to 0.71
DHA	Docosahexaenoic acid	0.24±0.04	0.10 to 0.47

3.3 Mortality pattern emu birds

Leg deformities were the most common cause of mortality in emu chicks. Majewska [15] recorded 30% of emu chicks were affected with leg deformities with 3.3% mortality. A leg deformity was associated with excess protein diet, improper calcium: phosphorus ratio, vitamin B (particularly niacin) deficiency in the feed [2]. Majewska [15] suggested excessive body weight was the causative agent for the leg deformities problem. Balanced diet with restricted feeding was followed to treat leg problems in this study and 52.96% affected chicks were saved.

Aspergillosis was the major problem between 15 to 50 days period of chick life. Totally, 9.33±3.06% (mean ± SD) chicks affected due to aspergillosis and 3.33± 1.16% chicks were died after 7 to 15 days of ailment. Affected chicks were maintained hygienically with proper ventilation and treated with 0.1% copper sulphate through drinking water. Fifty seven percentages of chicks affected with aspergillosis were responded to treatment.

According to Minnar and Minnar [2], irregular feeding or omitted feeding, presence of fibrous materials and lack of small stones in the shed could predispose a bird to impaction. In the present study, mortality due to impaction (mean ± SD) was 1.33±1.16% and 3.33±2.89% in the affected chicks and growers, respectively. The affected birds were treated with mineral oil orally for 5 to 7 days and 74.91% of the chicks and 60.10% growers responded to treatment. Impaction was the most common cause of mortality in emu growers. Only 3.33±4.71% (mean ± SD) adult birds were affected with impaction and responded to treatment very well without any mortality.

Salmonellosis was recorded (mean ± SD) 4.67 ± 4.16% in 1 to 7 weeks old emu chicks. Affected birds were depressed, lethargic and sitting with heads down for long periods. Sometimes watery diahhorea, purulent discharge from the eyes and joint problems were noticed in the affected chicks. The signs found in this study was in accordance with Vanhooser and Welsh [22] and they recorded salmonellosis in 23% of emu chicks aged 5 days to 5 weeks. Affected chicks were treated with sufadoxime + trimethoprim antimicrobials at 1% level through drinking water to save 71.5% chicks.

Emu chicks started showing gradual loss of appetite, lethargy, loss of weight, depression and ruffled feathers from 13th day onwards and 0.67±1.16% (mean ± SD) emu chick died at the age of 19th day due to aflatoxicosis. The feed sample was analysed and it was found to contain aflatoxin B_1 - 45 ppb and aflatoxin B_2 - 20 ppb. After withdrawal of feed, there were no further mortality and the remaining chicks recovered completely. The clinical signs, postmortem findings and histopathological findings in this study were similar to those previously described for other avian aflatoxicosis [22].

Papillomatosis were (mean ± SD) recorded 2.50 ± 4.33% and 2.22 ± 3.85% in the emu growers and adult birds, respectively. Wart lesions were noticed on the digits, legs, commissars of peak which affected movements and feed intake of the chicks. This restricted movements and off feed led to gradual body weight loss and mortality (mean ± SD) in 0.83±1.44% emu growers. Affected birds were treated with liquid nitrogen and antibiotic cream externally to save 67% of the affected growers. Affected adult birds were responded to treatment without causing any mortality. Interpretation of the results was also difficult due to the lack of records on the papillomatosis in emu.

Mortality was recorded (mean ± SD) in 1.67± 1.44% emu growers due to colisepticaemia. On necropsy, the bird revealed fibrinous pericarditis, perihepatitis, peritonitis, congestion of spleen, intestine and air sacs. Foul smelling fibrinous fluid was observed from the peritoneal cavity. Pure culture of *Escherichia coli* was isolated from the peritoneal fluid. Enrofloxacin 0.04 per cent were given to the affected

birds through drinking water consecutively for 5 days. Seventy five percentages of affected birds were responded for the treatment while 25% of birds were died after 3 days without showing any improvement. *E.coli* was also isolated from the bird died due to *e*gg bond peritonitis which caused mortality (mean ± SD) in 1.11 ± 1.93% adult emu bird aged 4 years and above.

Phallus and Cloacal prolapse was associated with severe diarrhoea, impaction of the intestine, nutritional deficiencies and tenesmus. Although the pathologies and etiology of the condition was unknown in this case, the bird was affected with impaction for 5 days before developing prolapse. It caused mortality (mean ± SD) 1.11± 1.93% in adult emu bird aged 4 years and above. Stress induced immunosuppression and poor husbandry practices related to feed, water or hygiene were some predisposing factors involved in cloacal prolapse in ratites. The clinical signs observed in this case were similar to those previously described in emu by Minnar and Minnar [2].

Self-inflicting wound and fracture of legs as a sequel of infighting cause were of challenging task in day–to-day management of captive emu adult birds (aged between 36 weeks to 192 weeks) during the initial breeding season. Fighting between the birds was reduced in the subsequent breeding seasons [2]. Injuries resulted due to either from each other (kicking/lacerations), or from running into fences, trying to escape the attacker. Fracture of legs due to fighting between the birds did not respond to any treatment and died after 15 to 20 days. The incidence of infighting injury was not recorded in the adult birds aged 4 years and above.

The overall mortality rate among the affected emu chicks (33.33%) was 11.99% by various diseases and deformities. In emu growers, 17.5% birds were affected and caused mortality in 5.83% growers. In adult emu birds, 5.55% birds were died among the 45.00% affected.

4. Conclusion

From the study, it can be concluded that, emu breeders were started to lay eggs from 764.1±44.39 days. Egg weight increased as age of the emu bird advances, but egg number increased upto 5 laying year and decreased in the 6th, 7th and 8th laying season. Under captive condition, emu birds laid eggs during October to February months which coinciding with the winter months. The eggs were laid at 3days interval and mostly in the evening hours. Palmitic acid, palmitoleic acid, stearic acid, oleic acid, linoleic acid, linolenic acid, arachidonic acid, eicosapentaenoic acid and docosahexaenoic acid were recorded in the emu eggs. Leg deformities and aspergillosis were the main causes of mortality in emu chicks. Impaction caused more mortality in emu growers. An in-fighting injury and egg laying problems were the major problems in the adult birds.

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