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ScienceDirect
Theriogenology 67 (2007) 1492–1502
Theriogenology
www.theriojournal.com

Changes in numbers of large ovarian follicles, plasma luteinizing hormone and estradiol-17β concentrations and egg production figures in farmed ostriches throughout the year

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Received 24 May 2006; received in revised form 28 February 2007; accepted 9 March 2007

Abstract

In this study we described and analysed changes in the numbers of large ovarian follicles (diameter 6.1–9.0 cm) and in the plasma concentrations of luteinizing hormone (LH) and estradiol-17β ($E_2\beta$) in relation to individual egg production figures of farmed ostriches (*Struthio camelus* spp.) throughout one year. Ultrasound scanning and blood sampling for plasma hormone analysis were performed in 9 hens on a monthly basis during the breeding season and in two periods of the non-breeding season. Our data demonstrated that: (1) large follicles were detected and LH concentrations were elevated already 1 month before first ovipositions of the egg production season took place; (2) $E_2\beta$ concentrations increased as soon as the egg production season started; (3) numbers of large follicles, LH and $E_2\beta$ concentrations were elevated during the entire egg production season; and that (4) numbers of large follicles, LH and $E_2\beta$ concentrations decreased simultaneous with or following the last ovipositions of the egg production season. By comparing these parameters during the egg production season with their pre-and post-seasonal values, significant differences were found in the numbers of large follicles and $E_2\beta$ concentrations between the pre-seasonal, seasonal and post-seasonal period; while LH concentrations were significantly different between the seasonal and post-seasonal period. In conclusion, our data demonstrate that changes in numbers of large follicles and in concentrations of LH and $E_2\beta$ closely parallel individual egg production figures and provide some new cues that egg production in ostriches is confined to a marked reproductive season. Moreover, our data provide indications that mechanism, initiating, maintaining and terminating the egg production season in farmed breeding ostriches are quite similar to those already known for other seasonal breeding bird species.

Keywords: Ostriches; Egg production season; Ultrasound scanning; Follicles; LH; Estradiol

1. Introduction

Egg production per hen per year is an important parameter to estimate the reproductive performance in farmed breeding ostriches (*Struthio camelus* spp.). Ostriches are considered to be seasonal breeders, although they may also breed all year round [1,2]. During the breeding season male and female ostriches are reproductively active from 6 to 8 months of the year, a period that in Northern hemispheres extends from March to September, and in Southern hemispheres approximately from July to February [3–5]. Generally, both wild and (semi) domesticated ostriches are

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doi:10.1016/j.theriogenology.2007.03.007

polygamous breeders. On farm, ostriches are kept in breeding paddocks, most frequently at a ratio of 1 male to 2 or 3 females, or in large breeding colonies that contain several males and females at a similar ratio. Some ostrich producers, however, prefer to keep them as breeding pairs (1 male and 1 female). Average egg production figures on farms vary between 30 and 50 eggs per hen per year [4,6] or even less [5]. Although some females are capable of producing 60 eggs or more per season, in general only few hens establish such a production level and variation between individual hens is large. This indicates that egg production performance can still be improved in ostrich farming. By contrast, in the domestic poultry industry egg production per hen has tremendously improved in the past decennia. Besides improved genetic selection for certain reproductive traits and the knowledge gained from studies on basic reproductive biology, other factors such as feeding, light-schemes, reproductive management and regular monitoring in flock control programs have all positively contributed to the increase of egg production potential in domesticated poultry [7].

In farmed ostriches, however, our knowledge of factors affecting and mechanisms regulating and maintaining (seasonal) egg production has still important gaps and has hardly gained attention. One study [2] showed that egg production in ostriches increased in spring when day length increased, and that peak egg production coincided roughly with the periods of maximum day length and decreased in autumn when day length started to decrease, suggesting that ostriches are photoperiod dependent. The same study [2] also described the monthly relationship between average egg production figures and average plasma hormone levels of estradiol-17β ($E_2\beta$) and luteinizing hormone (LH) in six female ostriches and it was observed that plasma levels of LH significantly increased 1 month before the start of the egg production season and decreased at the time egg production started declining. $E_2\beta$ levels increased at the start of egg production season, peaked when egg production was maximal and remained elevated throughout the rest of the egg production season. Lambrechts et al. [8] presented preliminary results on the use of diagnostic ultrasonography as a management tool to quantify egg production potential. They scanned females ($n = 136$) at the start of the egg production season, when males and females were joined as breeding pairs after a 3-month rest period. Hens with follicular activity at that time (two or more observed follicles; the diameter was not reported) laid their first egg earlier and produced more eggs during the first 2 months and over the entire egg production season, compared to hens that did not show follicular activity (one or no follicles). Bronneberg and Taverne [9] also described and validated an on-farm technique for transcutaneous ultrasonography and provided preliminary data illustrating the technique's potential value as a tool to predict egg production at the beginning and end of the egg production season. More recently, by performing ultrasound scanning and plasma hormone analysis during the ostrich' 48 h egg laying cycle at 3 h- and 1 h-intervals, respectively, Bronneberg et al. [10] demonstrated that reproductive events such as ovulation, egg development and oviposition evolve according to a rather strict time schedule. In eight ovulating hens, the authors showed that ovulation takes place within approximately 2 h after oviposition, and that the developing egg remains for 9 h in the proximal part (infundibulum, magnum and isthmus) and for 36 h in the distal part of the oviduct (uterus or shell gland) before oviposition takes place. By simultaneously performing plasma hormone analyses at 1 h-intervals, their study also revealed that progesterone, LH and $E_2\beta$ reach peak concentrations shortly before ovulation. Moreover, they demonstrated that ultrasound scanning is an easy on-farm technique to discriminate between ovulating and non-ovulating hens.

Currently, however, there are no known studies in which (diagnostic) monitoring tools, such as transcutaneous ultrasonography of the ovary and plasma hormone analysis, are used simultaneously to investigate follicular activity and endocrinological reproductive events throughout the year. By performing ultrasound scanning and plasma analysis of LH- and $E_2\beta$-concentrations on a monthly basis throughout the year, this study therefore aims to describe and analyse the changes in numbers of large ovarian follicles and changes in plasma hormone levels, in relation to the individual egg production figures of ostriches during the breeding and non-breeding season.

2. Materials and methods

2.1. Animals

Nine adult female ostriches (*Struthio camelus* spp.) were studied on a commercial farm in the Netherlands from February 2003 to February 2004, a period that included one complete breeding season and parts of two non-breeding seasons. Throughout the year, birds were kept under natural lightening conditions. Data on the mean monthly temperature (°C), the monthly precipitation sum (mL) and the mean monthly day length (the difference in hours between sunrise and sunset) during