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Laying, Egg and Hatchability Characteristics in Ostrich (*Struthio camelus*) at Different Age

Helena KONTECKA, Jolanta WO NICKA, Katarzyna WITKIEWICZ, and Sebastian NOWACZEWSKI

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The experimental material comprised 7 ostrich families (7 males and 14 females) of which five families were at the age of 7 and two at the age of 5 years. In the course of the entire reproductive season, the following parameters were analysed: length of the laying period, mean laying rate, number of eggs laid by one female, proportion of hatching eggs, egg weight and shape, egg weight lost during incubation, egg fertilisation, percentage of dead embryos and unhatched chicks, hatchability from fertilised and set eggs. Seven year-old ostriches were characterised by shorter laying period (134 days) but, at the same time, by higher proportions of hatching eggs. This group was also characterised by high egg fertilisation (79.7 %) as well as high hatchability indices at simultaneous highest embryo mortality during incubation (11.6 %). Five year-old ostriches exhibited a longer laying period (175 days) during which females laid more eggs (49 pcs.). In addition, this group was characterised by a smaller proportion of hatching eggs, better egg fertilisation indices (83.5 %) and hatchability results. Moreover, the determined higher egg shape index indicates that the 5 year-old females laid eggs which were more spherical. Recapitulating, the obtained results indicate that, under Polish conditions, better indices of laying performance, egg fertilisation and hatchability were observed in the group of 5 year-old ostriches.

Key words: Ostrich, reproduction, egg weight, egg shape, egg fertility, hatchability.

Helena KONTECKA, Jolanta WOŹNICKA, Katarzyna WITKIEWICZ and Sebastian NOWACZEWSKI, Department of Poultry Science, Poznań University of Life Sciences, Witosa 45, 61-693 Poznań, Poland.
E-mail: sebnow@jay.up.poznan.pl

Interest in ostriches, in particular their meat, increased all over the world in the 1980s (HORBAŃCZUK 2001) and it was then that numerous farms raising this kind of poultry were established not only in Africa but also in Australia, South America and Europe. In Poland, considerable interest in ostrich rearing was observed in the 1990s (HORBAŃCZUK & ARMATOWSKI 1996). The interest in ostrich meat was probably associated with its taste and dietary values (HORBAŃCZUK 2000) as this meat is characterised by low fat and cholesterol content. However, it is very unlikely for this meat to compete with pork or meat of other poultry species and it will always remain only an additional, attractive product of good quality.

The egg-laying of ostriches depends on many factors (ADKINS 1993; HORBAŃCZUK & SALES 2001). One of them is the age of birds. During the first year of laying, females lay fewer eggs than in consecutive years. Climatic conditions are also important. The most optimal conditions are found in southern Africa as evidenced by 30 to 35% higher laying ostrich in that area than in Europe. Thanks to the high adaptability of these birds, they have acclimated to a central European climate without any apparent problems (HORBAŃCZUK 2000).

One of the problems encountered in ostrich rearing consists of low hatchability indices in comparison with other poultry species. This is primarily due to the high death rate of embryos during the final phase of incubation, i.e. from day 35 of incubation (HORBAŃCZUK 2000). Hatchability results reported by MORE (1996), HORBAŃCZUK (2000) and SAHAN (2002) depend on many factors, including, among others: the quality of hatching eggs, handling of eggs before hatching and the applied incubation technique. This is one of the reasons for continued investigations aiming at the improvement of ostrich reproductive traits as well as development of artificial incubation (HASSAN *et al.* 2004; BRONNENBERG *et al.* 2007).

There is little information in the available scientific literature regarding ostrich reproduction under Polish

conditions, despite the fact that it is an important issue from the point of view of rearing profitability of this poultry species. We conducted an investigation with the aim of assessing the impact of ostrich age on reproductive parameters such as laying characteristics, egg fertilisation and hatchability of these birds raised under domestic conditions.

Material and Methods

The experiment was carried out at a private ostrich farm in 2008. The experimental material included 7 ostrich families (7 males and 14 females) of which five families were 7 years old and two families – 5 years old. Each family was composed of 1 male and 2 females. Birds were kept in wooden facilities neighboured by fenced runs partly sowed with grass and partly covered with bushes and trees. Throughout the reproductive period, the experimental birds were fed complete diets delivered once a day in the morning in the amount of 2.3 kg/bird which contained in 1 kg: 2300 kcal ME, 19% crude protein and 2.4% calcium. Ostriches began egg laying on the 11th of April, and finished on the 12th of October. Eggs were collected from runs every day between 5 and 7 p.m. The eggs were marked, weighed and their length and width were measured using slide callipers. Next, eggs were washed and disinfected, using for this purpose 0.5-1% Vircon S solution. In addition, eggshell quality was assessed; eggs with shell defects were discarded.

Eggs designated for hatching had no eggshell defects and their weight ranged from 1150 to 1750 g. Prior to setting in the incubator, the eggs were kept for a maximum of 7 days in a facility where the temperature was 16^{o}C and relative humidity 75% and where they were rotated twice a day by an angle of 90^{o}. In all, 221 and 159 eggs obtained from 7 and 5 year-old ostriches, respectively, were used in the experiment. Eggs were weighed before being placed in the incubator. Hatchings were conducted in cabinet-type incubators produced by the Fest Company. Until day 38, eggs were kept in the setting compartment in which the temperature was maintained at 36.6^{o}C and relative humidity at 20%. On day 39, the eggs were weighed before their transfer to the hatching compartment in which the temperature was at 36^{o}C and relative humidity at 50%. Each time, 20 to 25 eggs were loaded into the setting compartment because there were only two incubators on the farm with a capacity of 12 eggs each. After hatching, the chicks were assessed and unhatched eggs were opened in order to determine the number of unfertilised eggs as well as eggs with dead embryos or unhatched chicks.

The following characters were determined:

– length of the reproduction period (days),

– mean laying rate (%) – from the ratio of the number of laid eggs in a given period to the mean number of layers and number of days,

– number of eggs (pcs.) laid by one female,

– proportion of hatching eggs (%) in relation to the number of eggs laid in each age group,

– egg weight (g),

– egg shape index (%),

– egg weight lost (%) – from the difference of the egg weight before setting and on day 39 of hatching,

– egg fertilisation (%),

– proportion (%) of dead embryos and unhatched chicks in relation to fertilised eggs,

– hatchability from fertilised and set eggs (%).

The obtained results were analysed statistically using the SAS v. 9.1 statistical package. The significance of differences between age groups of ostriches in regard to reproductive traits, egg shape index, egg weight lost during hatching and hatchability was verified by the Students *t*-test and statistical differences were established at the level of $P \leq 0.05$.

Results

An assessment of ostrich reproductive traits is presented in Table 1. The reproductive season began on the 11th of April and lasted until the 12th of October. In comparison with 7 year-old ostriches, birds from the 5 year-old group were characterised by a 41-day longer reproductive period. No statistically significant differences were observed between age groups for laying rate and egg numbers laid by one female. However, a higher mean laying rate and number of eggs per female were found in the case of 5 year-old birds. On the other hand, a significantly higher (by 30.9%) proportion of hatching eggs was observed in 7 year-old birds.

Mean values of egg weight, egg shape index and egg weight lost during hatching are presented in Table 2. The examined ostrich age-groups did not differ in regard to the above-mentioned traits. However, 5 year-old ostriches laid lighter and more spherical eggs. The mean egg weight of eggs selected for hatching ranged from 1405.9 g to 1524.9 g.

Table 3 presents mean values of egg fertilisation and hatchability. Egg fertility in the flock of 7 year-old birds was smaller by 3.8%. The determined differences were not statistically significant. The large number of embryos that died over

Table 1

Characteristics of reproductive traits in ostriches

Trait	Age			
	7 year-old		5 year-old	
	mean	SEM	mean	SEM
Length of the reproduction period (days)	134*	7.22	175*	17.00
Laying rate (%)	26.5	2.54	27.9	3.86
No of eggs per female (pcs)	35.0	2.56	49.0	11.50
Hatching eggs proportion (%)	71.0*	4.66	40.1*	0.70

*Mean values differ significantly at the level $P \leq 0.05$

Table 2

Characteristics of some eggs traits in ostriches

Trait	Age			
	7 year-old		5 year-old	
	mean	SEM	mean	SEM
Egg weight (g)	1456.7	39.06	1405.9	55.80
Egg shape index (%)	82.2	0.67	85.5	1.50
Egg weight lost during 39 days of incubation (%)	15.9	0.65	16.1	0.75

No significant differences

Table 3

Characteristics of eggs fertilisation and hatchability in ostriches

Trait	Age			
	7 year-old		5 year-old	
	mean	SEM	mean	SEM
Egg fertilisation (%)	79.7	2.85	83.5	2.05
Dead embryos (%)	11.6	3.00	6.6	0.97
Unchatched chicks (%)	4.2	1.53	7.9	1.55
Hatchability from fertilised eggs (%)	75.6	3.16	82.7	0.35
Hatchability from set eggs (%)	60.3	3.65	69.0	2.00

No significant differences

the course of hatching were also observed in eggs from older birds. On the other hand, eggs laid by 7 year-old females were characterised by the lowest number of unhatched chicks. Better hatchability from fertilised and set eggs was recorded for 5 year-old birds. However, the observed difference was not confirmed statistically. A higher number of chicks was obtained per female ($\bar{x}$ = 15.0 pcs.) from 7 year-old females than from 5 year-old birds ($\bar{x}$ = 13.6 pcs.).

Discussion

The reproductive period in experimental ostriches began on the 11th of April and ended on the 12th of October, lasting for 191 days. An identical length of the laying season was also reported on another ostrich farm in Poland in 1998 (HORBAŃCZUK 2001). Laying initiation and termination in ostriches as well as the number of eggs laid by one female depend, among others, on climatic condi-

tions (BUNTER *et al*. 2001). These are optimal in South Africa because the climate there is warm and dry. That is why the reproductive season in South Africa lasts 8 months during which over 60 eggs are obtained from one female, while in Europe these birds lay eggs for a period of 6 months and the number of eggs obtained from one female is at the level of 40 eggs.

Five year-old ostriches were characterised by a longer reproductive period, better mean laying rate and higher number of eggs from one female. According to HORBAŃCZUK and SALES (2001) and BUNTER *et al*. (2001), laying increases together with the age of females. In our experiment, 7 year-old birds laid fewer eggs than 5 year-old females. On the other hand, females from this age group were characterised by a smaller proportion of hatching eggs (40.1%) which was connected with eggshell defects, whereas a higher proportion (71%) of eggs was derived from older ostriches.

The weight of ostrich eggs selected for hatching corresponded to the domestic standard of ostrich hatching eggs which, according to HORBAŃCZUK (2000), should be contained within the interval of 1200 to 1800 g since egg weight exerts a significant influence on hatchability. The best hatchability results are obtained when the mean egg weight ranges from 1400-1650 g (GONZALES *et al*. 1999; IPEK & SAHAN 2002). In our study the mean egg weight was centred within this interval.

According to HORBAŃCZUK (2001), egg shape preconditions appropriate positioning of the embryo. In our investigation, the shape index ranged from 82.2 to 85.5%. Egg shape is species-specific and in the case of ostriches, according to Krumbiegel after HORBAŃCZUK (2001) as well as JARVIS *et al*. (1985), it lies within the 76-85.5% interval. Values obtained in this study do not exceed this range. However, the mean values for ostrich egg shape found most frequently in the scientific literature on the subject (KEFFEN & JARVIS 1984; REINER *et al*. 1995; MAJEWSKA *et al*. 2005) range from 82-83%, therefore it can be proposed that in comparison with chicken eggs (shape index 73-78%), ostrich eggs are more spherical. In experiments described by HORBAŃCZUK (2000), eggs derived from the first laying period were characterised by the highest value of the shape index (84-85%) which decreased in consecutive years (to 81-82%). The results obtained in our investigation were similar because the recorded shape index of eggs laid by 7 year-old ostriches was smaller. The higher value of the egg shape index of 5 year-old birds indicates that these eggs were more spherical which may be associated with smaller egg weight in this age group. NOWACZEWSKI *et al*. (2008) and NOWACZEWSKI *et al*. (2010) observed that lighter eggs of guinea fowl and Japanese quail were characterised by a greater shape index. In the case of guinea fowl eggs, this relationship was corroborated by a negative phenotype correlation coefficient of these traits amounting to r_p = - 0.424.

The egg weight lost durin g 39 days in the setting compartment of the incubator was at the level of 16.0% and can be considered as appropriate because ostrich egg weight loss should not be smaller than 10% or higher than 20% according to DEEMING (1997). BADLEY (1997) maintains that proper water loss from eggs during hatching should range from 12 to 16%. In experiments carried out by GONZALES *et al*. (1999) and HORBAŃCZUK (2000), egg weight loss was lower (13.3% on average) than in our investigations despite similar temperature and relative humidity in the setting compartment. However, eggs weight loss during hatching depends on other factors, i.e. on the weight of the eggs as well as the thickness and porosity of their shells (SATTENENI & SATTERLEE 1994; SAHAN *et al*. 2003). For example, KOŻUSZEK *et al*. (2009) also found that pheasant eggs of greater weight were characterised by lower water losses during the first 21 days of incubation in comparison with lighter eggs.

Egg fertilisation values in 5 and 7 year-old groups determined at about 81.6% can be considered as high because HORBAŃCZUK (2001) as well as MAJEWSKA *et al*. (2005) reported smaller values on domestic farms, i.e. 71.2 and 46.6%. On the other hand, values reported by DEEMING (1996) on British farms and by MORE (1996) on Australian farms were 78.7 and 68.1%, respectively. Higher egg fertilisation values registered in this study can testify, for example, to better biological values of the examined eggs resulting from, among others, proper rearing conditions. However, egg fertilisation percentage in ostriches is lower than in other poultry species. For example in hens it often exceeds 95%.

Higher embryo mortality was recorded in the group of 7 year-old ostriches. MORE (1996), SCHALKWYK *et al*. (1998) and HORBAŃCZUK (2000) reported even worse (less than 80%) ostrich embryo viability during incubation. Therefore, the hatching results recorded in this experiment can be considered as satisfactory, indicating the good biological value of the assessed eggs as well as correctness of the applied hatching technique.

Higher hatchability from fertilised eggs was recorded in 5 year-old ostriches. The value of this parameter reported by MAJEWSKA *et al*. (2005) in 5 year-old ostriches ranged from 55.5 to 84.6%, while IPEK & SAHAN (2004) demonstrated increased values of hatchability together with age of ostriches amounting to 63.4% in the first period of reproduction and increased to 73.1% in the fifth

laying season. Bearing in mind lower hatchability indices in ostriches than in other poultry species, the values obtained in this experiment can be considered as high and satisfactory.

Recapitulating, the obtained results show that under Polish conditions, 5 year-old ostriches were characterised by better indices of laying performance (with the exception of the proportion of hatching eggs), egg fertilisation and hatchability results. Despite the lower mean value in the proportion of hatching eggs in this age group, the number of chicks obtained from one female was high (on average 13.6).

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