The effect of dietary energy and protein levels during a breeding season of ostriches (*Struthio camelus domesticus*) on production the following season

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Abstract

In a study on ostrich nutrition that spanned three breeding seasons, we assessed the effect of different energy and protein levels in the previous breeding season on production in the following breeding season. During the first breeding season, groups of breeding ostriches were fed diets with energy levels of 8.5, 9.5 and 10.5 MJ metabolisable energy (ME)/kg dry matter (DM) and protein levels of 13.5, 15.0 and 16.5%. Amino acid profile was balanced and was related to the protein content in all cases. In the second breeding season, groups were fed diets with levels of 7.5, 8.5 and 9.5 MJ ME/kg DM and 10.5, 12.0 and 13.5% protein, and during the third breeding season all the breeding birds were fed a single diet of 9.5 MJ ME/kg DM and 12% protein. Different levels of dietary protein in previous years had no effect on egg production, egg weight, fertility, hatchability and initial chick weight in subsequent years of production. Different levels of dietary energy in previous years had no significant effect on the body weight of breeding females, initial egg weight or the percentage of infertile eggs produced over the three seasons, but females fed diets containing only 7.5 MJ ME/kg DM during the second year produced significantly fewer eggs in the third breeding season, resulting in fewer chicks being hatched. It was concluded that there are potential carry-over effects of dietary energy levels from one year to the next and that an energy level of less than 8.5 MJ ME/kg DM in the diet may have an adverse effect on egg production in breeding female ostriches in following breeding seasons.

Keywords: Ostriches, breeders, nutrition, protein levels, amino acid levels, carry-over effect
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Introduction

Although there has been a thriving ostrich industry in South Africa for more than a century, relatively little is known about the specific nutritional needs of ostriches (*Struthio camelus domesticus*). Studies on the metabolisable energy (ME) of specific components used in diet formulation and in balanced diets have shown that ostriches have an enhanced digestive capacity compared with other poultry species (Cilliers, 1994; Brand *et al.*, 2000b). Salih *et al.* (1998) and Brand *et al.* (2000a) have shown that the feeding of young ostriches on low-energy diets has no adverse effect on their growth rate. Little is known, however, about the specific nutritional needs of adult ostriches during the breeding season. Nutrition plays an important role in egg production in female birds and has to meet nutritional requirements for the maintenance of body condition and nutrients for egg production (Carey, 1996). This may be especially important in female ostriches on commercial farms, where the repeated removal of eggs for artificial incubation results in these birds laying several times the natural clutch of eggs in a breeding season. The ostrich industry is subjected to market trends, and in times of economic hardships there is pressure on ostrich farmers to reduce production costs. Because feeding costs represent about 70-80% of the total production cost, feed quality, especially energy and protein levels, are often the first to be compromised. Although breeding ostriches appear to perform equally well on lower and higher energy and protein diets, too low an energy level is a limiting factor in egg production (Brand, 2002). The longer-term effects of reduced dietary energy and protein levels are, however, not known. A study over two breeding seasons to assess the effect of different dietary energy and protein levels on production in breeding female ostriches allowed us to assess the effect of different dietary energy and protein levels fed to the birds in a previous breeding season on the production of breeding female ostriches in the following year.

Materials and Methods

Experimental birds used in the study were African black ostriches from the commercial ostrich breeding flock at the Little Karoo Agricultural Development Centre near Oudtshoorn, South Africa. The management of the breeding flock was described by Van Schalkwyk *et al.* (1996), and egg collection, subsequent treatment and incubation by Van Schalkwyk *et al*. (1998).

The trial ran over three breeding seasons (1998/1999, 1999/2000 and 2000/2001). For the first and second breeding seasons, 90 pairs of adult breeding ostriches were divided randomly into nine groups of 10 pairs/group during each experimental year. Groups, therefore, comprised of different breeding pairs during each successive breeding season; for example, birds on the diets with low nutrient densities during the first year were divided into the three energy groups in the second year. The breeding pairs were kept in separate breeding pens throughout the whole breeding season. During the first breeding season groups were fed diets with energy levels of 8.5, 9.5 and 10.5 MJ ME/kg dry matter (DM) and protein levels of 13.5, 15.0 and 16.5%. Corresponding lysine concentrations were 6.5, 7.5 and 8.5 g/kg. In the second breeding season groups were fed diets with energy levels of 7.5, 8.5 and 9.5 MJ ME/kg DM and protein levels of 10.5, 12.0 and 13.5%. Corresponding lysine concentrations were 4.9, 5.9 and 6.9 g/kg. All other amino acids were balanced according to requirements. Diets fed are described in detail elsewhere (Brand, 2002). In the third breeding season all the breeding birds were fed the same diet, which contained 9.5 MJ ME/kg DM and 12.0% protein with a lysine concentration of 5.9 g/kg. Diet formulation was based on nutrient values presented in the Elsenburg Ostrich Feed Databases (Brand, 2000). The feed was milled to pass a 3-mm sieve and then pelleted. Each bird was given a ration of 2.5 kg DM/d throughout the breeding season (June – January). Body weight of the female ostriches was determined at the beginning and end of the breeding season. Egg production, egg weight and fate of eggs set in the incubator were recorded throughout each breeding season. As is common practice on South African farms, females were separated from the males after the breeding season for a four-month rest period. During this period (February – May), the birds were fed a maintenance diet.

Data were analysed according to a 3 energy x 3 protein factorial design, in which the energy and protein levels of the previous year featured as the main factors (Statgraphics, 1991).

Results

No significant interactions between energy and protein levels were observed. The main effects of the different energy and protein levels in the diet are consequently presented separately.

Mean body weight of females at the start of the first breeding season averaged between 115 and 120 kg and did not differ ($P > 0.40$) between groups assigned to different diets (Table 1). Females on all diets lost an average between 16.7 and 18.3 kg over the course of the second breeding season, but their body weight did not differ ($P > 0.20$) between groups at the end of the season (Table 1). There was an increase in the weight of birds in all groups during the rest period. At the beginning of the second breeding season the weight of female ostriches ranged between 112 and 117 kg ($P > 0.50$). During the third breeding season all birds were fed the same diet (9.5 MJ/kg) and gained between 0.10 and 9.5 kg over the course of the breeding season. Mean weights did not differ ($P > 0.50$) at the end of the season (Table 1).

Egg production in the first season following the year in which birds were subjected to different nutritional regimes ranged from 40 to 47 eggs/female and did not differ ($P > 0.15$) between the various groups (Table 1). Similarly, the proportion of chicks hatched and hatchling weight did not differ significantly for birds fed different energy level diets the previous year (Table 1). During the second breeding season, after different feeding regimes had been followed, egg production ranged between 29 and 51 eggs/female. Females fed the 7.5 MJ ME/kg diet the previous year laid fewer ($P < 0.02$) eggs than the breeders fed the 8.5 MJ ME/kg diet the previous year (Table 1), but did not differ from those fed the 9.5 MJ/kg diet the previous year. The number of chicks hatched from females fed the 7.5 MJ ME/kg diet (14.2) was also lower ($P < 0.025$) than the 30 chicks hatched from birds fed the 8.5 MJ ME/kg diet the previous season, although difference in hatchling weight only approached significance ($P = 0.059$). No significant difference occurred in the initial egg weight between groups fed the different diets and a lower energy diet fed in a previous year seems to have no adverse effect on the percentage of chicks hatched or chick weight at hatching.

Table 1 The effect of dietary energy levels received in the previous year on production of female ostriches during the successive year (mean ± s.e.)

Production Parameters	Production in the first successive year Energy level (MJ ME/kg) fed the previous year			Significance level (P)	Production in the second successive year Energy level (MJ ME/kg) fed the previous year			Significance level (P)
	8.5	9.5	10.5		7.5	8.5	9.5	
Number of animals, n	20	18	23		20	21	20	
Starting weight, kg	114.6 ± 3.2	119.9 ± 3.4	119.8 ± 3.0	0.420	111.9 ± 3.0	117.2 ± 4.3	115.3 ± 3.1	0.557
End weight, kg	96.3 ± 3.3	102.0 ± 3.5	103.1 ± 3.1	0.288	120.0 ± 4.6	117.3 ± 6.3	124.8 ± 4.6	0.594
Production								
Egg production, n	47.4 ± 5.3	46.0 ± 5.6	40.8 ± 5.0	0.632	28.7 ± 4.5[a]	51.3 ± 6.3[b]	40.6 ± 4.6[ab]	0.016
Live chicks hatched, n	27.7 ± 4.4	25.4 ± 4.6	23.1 ± 4.1	0.753	14.2 ± 3.7[a]	30.8 ± 5.1[b]	23.2 ± 3.7[ab]	0.033
Live chicks hatched, %	57.3 ± 5.5	48.8 ± 5.8	56.7 ± 5.2	0.503	40.8 ± 6.6	58.8 ± 9.0	50.7 ± 6.5	0.253
Hatchling weight, g	876.1 ± 18.8	855.6 ± 20.6	862.9 ± 17.0	0.752	874.6 ± 10.4[a]	842.8 ± 11.0[b]	876.8 ± 10.6[a]	0.059
Egg weight								
Initial weight, g	1452.0 ± 23.8	1448.4 ± 25.8	1435.1 ± 22.3	0.861	1438.6 ± 28.8	1418.4 ± 31.1	1391.6 ± 24.2	0.455

[a,b] Denote significant ($P \leq 0.05$) difference within rows within successive year

Table 2 The effect of dietary protein levels received in the previous year on production of female ostriches during the successive year (mean ± s.e.)

Production Parameters	Production* in the first successive year Protein (%) fed the previous year			Significance level (P)	Production* in the second successive year Protein (%) fed the previous year			Significance level (P)
	13.5	15.0	16.5		10.5	12.0	13.5	
Number of animals, n	24	13	24		23	17	21	
Starting weight, kg	121.0 ± 3.2	115.9 ± 3.1	117.6 ± 3.3	0.522	113.7 ± 3.2	115.9 ± 3.9	114.8 ± 3.4	0.910
End weight, kg	105.7 ± 3.3	97.2 ± 3.2	98.6 ± 3.4	0.157	123.3 ± 4.7	114.6 ± 5.7	124.3 ± 5.1	0.393
Production								
Egg production, n	38.5 ± 5.3	42.7 ± 5.2	53.0 ± 5.4	0.156	41.1 ± 4.6	43.3 ± 5.8	36.2 ± 5.1	0.621
Live chicks hatched, n	21.7 ± 4.4	26.7 ± 4.3	28.1 ± 4.5	0.575	24.8 ± 3.9	19.5 ± 4.7	24.0 ± 4.1	0.661
Live chicks hatched, %	48.8 ± 5.5	60.6 ± 5.4	53.5 ± 5.6	0.309	55.8 ± 6.8	37.6 ± 8.2	57.0 ± 7.2	0.154
Hatchling weight, g	865.8 ± 20.3	845.5 ± 17.6	883.4 ± 18.5	0.334	878.0 ± 9.2	864.9 ± 10.4	851.3 ± 12.1	0.225
Egg weight								
Initial weight, g	1452.6 ± 24.6	1418.7 ± 23.1	1464.3 ± 24.2	0.372	1451.7 ± 23.9	1381.2 ± 29.5	1415.6 ± 30.6	0.187

* Differences not significant

The mean weight at the start and end of the first breeding season did not differ (P > 0.10) between groups assigned to different dietary protein levels fed the previous year. Again, all birds gained weight during the rest period. During the second breeding season no differences (P > 0.90) in weight were evident between birds assigned to different diets at the start. The females fed the 12.0% protein diet lost 1.3 kg by the end of the season, whereas those on the 10.5 and 13.5% protein diets gained between 9.2 and 9.6 kg. The mean weight of the groups did not, however, differ (P > 0.39; Table 2).

No significant difference was found between the various treatments during the first breeding season. No differences were evident in the percentage of chicks hatched or the hatchling weight, from eggs produced by birds fed different levels of dietary protein (P's > 0.5). During the second breeding season the egg production was between 36.2 and 43.3 eggs/female, and again, no difference was found between groups fed the different diets in the previous season, nor was there a significant difference in egg weight, proportion of chicks hatched or hatchling weight (Table 2).

Discussion and Conclusions

Provision of adequate and appropriate nutrition is especially important for females to maintain their egg production from season to season. There are apparently no reports on carry-over effects in other species of birds. Such effects may, however, not always be evident with domestic chickens because the length of their production cycle cannot be compared with that of ostriches. Although neither energy nor protein had a carry-over effect on the weight of breeding ostrich females, presumably because birds had the opportunity to gain weight during the rest period, energy levels of 7.5 MJ ME/kg DM fed in the previous breeding season seemed to reduce egg production in the successive season and, consequently the proportion of chicks hatched from these birds, although the hatchling weight was not affected. It may be concluded from this study that, although birds may be able to recover their body weight fully after a season of being fed very low energy diets, a diet of less than 8.5 MJ ME/kg DM may reduce egg production of female ostriches in the following year.

Acknowledgements

Financial assistance of the Klein Karoo Co-operative at Oudtshoorn, Elsenburg Agricultural Centre and the National Research Foundation's THRIP programme is gratefully acknowledged.

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