ISSN 1682-8356
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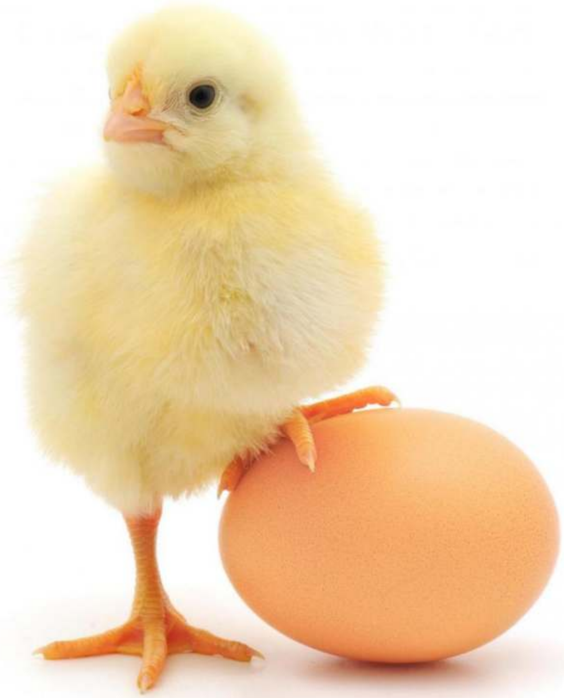

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

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International Journal of Poultry Science 2 (5): 293-299, 2003

On Farm Assessment of High Fibre Dietary Sources for Grower and Finisher Ostriches

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Abstract: Feed comprises over 60% of the cost of growing ostriches to slaughter weight. Any saving in feed costs would contribute greatly to the overall profitability of the ostrich industry. Very cheap sources of fibre are available to feed ostriches in Australia. The purpose of these experiments was to examine; i) the role of fibre digesting enzymes in improving the utilization of lucerne silage and ii) to provide information on the role of lucerne silage, lucerne and pea straw in supplementary diets. The first trial compared the growth of ostriches from 32-36 weeks-of-age fed a commercial finisher diet (with and without a glycanase enzyme) with a lucerne silage diet (also with or without enzyme supplementation). The birds on the silage diet (with enzyme) had a significantly ($P<0.05$) lower body weight (79.7 kg) than the birds on the commercial finisher diet (85.9 kg) after 4 weeks of feeding, but there were no significant differences between the other diets. The silage wasted by the ostriches was considerable and estimated to be about 60% of the total offered. In practical situations birds would need to be given a greater opportunity to adapt to the diet and for the silage to be chopped to 5 cm in length to ensure enough feed was consumed to achieve the same growth as the birds on the commercial finisher diet. For grower birds fed a 24 and 40% pea straw diet and a 20% lucerne diet from 24-30 weeks-of-age, body weight of birds on the commercial grower (57.7 kg) and lucerne diet (54.3 kg) were significantly higher ($P<0.05$) than the 24% pea straw diet (50.1 kg) and 40% pea straw diet (48.9 kg) at 27 weeks. The poor performance of birds on pea straw diets might result from birds consuming twice the fibre intake and 30% lower energy than those birds on the commercial diet. This experiment was only conducted over 6 weeks. Giving the birds greater time on the diets might have allowed the birds to adapt to consuming higher levels of forage.

Key words: Ostrich farming, grazing, fibrous feeds

Introduction

The ostrich is a simple stomached animal with a very long digestive tract (Fowler, 1991; Skadhauge *et al*., 1984; Swart *et al*., 1993), which has developed the ability to utilize roughage (Smith and Sales, 1995). Their elongated hindgut (particularly the caeca) allows the retention of plant fibers for degradation by gut micro flora (Hastings, 1994). The digestion of dietary fibre can provide as much as 76% of the bird's energy requirements (Swart *et al*., 1993; Swart, 1988). Lucerne is a popular dietary ingredient for ostriches due to its relatively high crude protein (CP) content (18%), crude fibre (CF) content (30%), apparent metabolizable energy (AME) of 8.9 MJ/kg and 50.1% dry matter digestibility (DMD). Although lucerne is the most desired forage for ostriches of all ages, it is expensive and difficult to grow in dry areas unless irrigation is available. Feed comprises over 60% of the cost of growing ostriches to slaughter weight and any saving in feed costs would contribute greatly to the overall profitability of the ostrich industry. There has been recent work examining whether other cheap high fibre sources could be a substitute for lucerne. Cilliers *et al.* (1994) concluded that wheat bran (18% CP and 13% CF) could be a useful alternative for lucerne in ostrich diets. Cilliers *et al.* (1998) demonstrated the potential of maize silage as a source of nutrient supply for growing ostriches (50-70 kg). Likewise wheat straw (CP 3.0% and CF 42%), Rhodes grass (12.5% CP and 32% CF) can replace about 20% of lucerne meal in the ostrich diets without affecting the bird's performance (Farrell *et al*., 2000). Common reed and saltbush could also be alternatives for lucerne (Cilliers *et al*., 1999). However a high proportion of these roughages in the diet could cause a detrimental effect on the performance of ostriches. Farrell *et al.* (2000) determined the forage intake for ostriches grazing Rhodes grass, Kikuyu grass and white clover pastures and fed diets as low as 7.5-8 MJ/AME/kg. Substantial amounts of concentrate feed can be replaced by grazing if the pasture is of good quality. This suggests there is a possibility of achieving maximum production in ostriches at least cost, by providing roughage or pasture

Table 1: Diet formulation for the complete lucerne silage diet, the concentrate proportion (excluding lucerne silage) and commercial diet for finisher ostriches in experiment 1

Ingredient	Complete diet %	Diet excluding silage (concentrate) %	Commercial finisher diet
Oats	53.75	67.19	
Barley			36.4
Maize			14.7
Lucerne Silage (air dry)	20	-	
Oat hulls			12.0
Malt mix			12.5
Rice Hulls	10	12.5	
Pre-mix	0.25	0.31	0.25
Pea meal			2.8
Canola meal (solv)	10	12.5	10
Soybean (48%)			1.6
Oil	1	1.25	
Limestone			2.3
Dicalcium phosphate			0.1
Salt			0.25
Lucerne meal			5
DL Methionine			0.13
Molasses	5	6.25	0.5
TOTAL	100	100	100

sources with a suitable concentrate supplementation. Cheap fibers sources such as, rice hulls, mill run, maize silage, lucerne silage, grass silage, pea, barley, wheat and oaten straw are available in Australia. In some of the current diet formulations for ostrich, soybean and lucerne meal account for a certain proportion to meet protein requirements for growing ostriches but these materials are very expensive and finishing ostriches tend to over consume feed.

The reliance on fibre from pasture in the later stages of growth may enable the use of fibre digesting enzymes to improve the utilization of pasture and cheap supplementary fibre sources. Exogenous enzyme supplements are used widely in poultry diets to improve nutrient utilization (Acamovic, 2001). Including enzymes such as multi-cocktail glycanases, which has a high affinity for insoluble fibers, has the potential to degrade fibre into small polymers and consequently improve the nutrient utilization efficiency (M. Choct, pers. comm.).

To investigate the role of cheap high fibre sources in ostrich nutrition two trials were undertaken. The first trial compared the growth of ostriches fed a commercial finisher diet (with and without a glycanase enzyme) with a lucerne silage diet (also with or without enzyme supplementation). The second experiment examined the role of pea straw in grower diets. The purpose of these experiments was to provide information, which would assist in the formulation of cheap high fibre diets, which could be fed to ostriches while grazing pastures and grain stubbles.

Materials and methods

Paddocks: Both trails were conducted on a commercial ostrich farm located near Winchelsea in Victoria, Australia. Four identical paddocks (30 m x 70 m) with 7 m high fences were established. The paddocks contained no forage. Water was available ad libitum. A commercial facility was utilized so that the results obtained were relevant to the industry.

Diet formulation: In the first trial a finisher diet (with and without Avizyme 1302) using lucerne silage as the fibre source (Table 1) was formulated to meet the nutrient requirements of ostriches (AME=10.5 MJ/kg; CP=12.5%; CF=16%; feed allowance of 2.0 kg/bird/day) recommended by Cilliers (2000) for a 70 kg bird. A commercial finisher diet (AME=9.6 MJ/kg, CP=14.7 %, AME=9.6 MJ/kg and CF=9% with and without Avizyme 1302) was used as the comparison with the lucerne silage diet (Table 2). In the second trial a grower diet comparing lucerne chaff and two levels of pea straw chaff (24 and 40%) was formulated to contain approximately an AME of 12 MJ/kg, 18% CP and 7% CF fed at 1.6 kg/bird/day (Table 5). These diets were compared to a commercial grower diet containing approximately an AME of 9.6 MJ/kg, 14.7% CP and 11% CF (Table 5). The feed company recommended the feed intake for growers (kg/day) on the commercial diet should be 1.6 kg (Table 6). The test diets contained a large proportion of fibrous feed, which were fed separately to the concentrate diet. This ensured birds on the high fibre diets were offered a similar quantity of feed (Table 6) as birds provided the commercial diet. Teangi Stock feeds, Gun bower, Australia prepared the concentrate forms of the above diets (Table 1 and 5). The fibre portions of the diet were chopped to 5 cm in length and fed separately from the concentrate portion of the diet (Cilliers, pers. comm.). In the first trial the lucerne silage was fed without chopping, to save costs and to make the handling of silage easier, while in the second trial the lucerne and pea straw chaff were cut into 5 cm lengths using a chaff cutter.

Table 2: Diet specifications of the lucerne silage and commercial diet for finisher birds in experiment 1

Nutrient	Lucerne silage (%)	Commercial finisher (%)
DM	88.10	92.44
AME (MJ/Kg)	10.54	9
CP	12.57	14.2
Fibre	16.38	9
ADF	6.69	NA
NDF	6.20	NA
Threonine	0.44	0.41
Serine	0.45	0.74
Alanine	0.45	0.64
Valine	0.64	0.66
Methionine	0.21	0.25
Phenylalanine	0.45	0.68
Histadine	0.23	0.34
Lysine	0.57	0.64
Isoleucine	0.49	0.55
Tyrosine	0.39	0.46
Arginine	0.62	NA
Leucine	0.79	1.03

NA = not available

Birds

Experiment 1-finisher ostriches: In March 2002 a group of 8-month-old ostriches were separated from a larger group of ostriches. Twenty ostriches in the weight range 72-74 kg were allocated to each paddock and allowed 3 weeks to acclimatize to the paddocks and adapt to being fed the lucerne silage. The lucerne silage was presented in its natural form without being chopped. The 3 week acclimatization was required as birds tend to show fear of the appearance of new food sources when placed in a paddock and take time to approach the forage and begin consumption. Sex of the birds was determined at the end of the experiment.

Experiment 2-grower ostriches: In September 2002 a group of 6-month-old ostriches were separated from a larger group of ostriches. Twenty ostriches in the weight range 45-50 kg were allocated to each paddock. Birds were allowed 3 weeks to adapt to a high fibre source by being fed lucerne chaff.

Diets

Experiment 1-finisher ostriches: After the adaptation period birds were weighed and allocated the diets. The silage was placed in large tractor tyres (1.5 m diameter; two feeders/paddock) with the concentrate diet (pellets) tipped on top of the chaff. All birds were observed to feed at the same time (10 birds/feeder), which reduced competition for feed. Birds were fed the diets for 4 weeks and then weighed.

Experiment 2-grower ostriches: After the adaptation period birds were allocated to the diets. The pea straw and lucerne chaff (chopped to about 5 cm in length on this occasion) was placed in large tractor tyres (1.5 m diameter; two feeders/paddock). The concentrate diet (pellets) was tipped onto the top of the fibre source every second day to ensure all birds consumed their share of concentrate. The feeding protocol allowed all the birds to eat at the same time and reduced any competition for the concentrate. Birds were fed the diets for 6 weeks and weighed at 3 and 6 weeks-of-age. Skip a day feeding was practiced for feeding of the concentrate diet so that ostriches would have time to consume the volume of lucerne and pea straw chaff.

Statistical design: The paddocks were selected at random for each treatment. For the purposes of this experiment each bird was considered a replicate. This decision was made on the basis of the paddocks being alike in all respects and each bird having equal access to the diets. The data was analyzed using the GLM procedure in SAS (1988).

Results

Experiment 1-finisher ostriches: During experiment 1, the feed wastage was not measured due to strong winds dispersing the forage. More importantly birds selected the leaf material of the silage and left the stork. However, an approximate estimate of daily forage intake (40% intake of forage offered) was provided by the property owner conducting the trial. On the basis of this estimate, crude protein intake was calculated and found to be markedly lower for the birds on silage compared to the commercial diet, while fibre intake was higher (Table 3). Amino acid consumption for most of the key amino acids was depressed for the birds fed the lucerne silage (Table 3). At the conclusion of the trial birds fed the commercial finisher diets and lucerne silage were significantly different in weight (Table 4). The birds on the silage diet (with enzyme) had a significantly lower ($P<0.05$) body weight than the birds on the commercial finisher diet, but were not significantly different than the other diets. When growth over the period of the experiment was considered the birds feeding on the silage with enzyme were not different from the silage only diet but had significantly poorer ($P<0.05$) growth than the 2 commercial diets with and without enzyme.
There was no difference in the growth of males and females on the diets (Table 5).

Experiment 2-grower ostriches

Wastage: The property owner was able to weigh the wastage in this trial. After week 1, 6.5 kg of lucerne stalk

Table 3: Estimated nutrient intake of ostriches fed a commercial finisher and a silage diet with or without avizyme 1302-experiment 1

Nutrient	Commercial finisher	Commercial finisher + enzyme	Lucerne Silage	Lucerne Silage +enzyme
Dry Matter (kg/day)	1.756	1.756	1.531	1.531
AME (MJ/day)	19.9	19.9	18.8	18.8
CP (g/day)	282.8	282.8	219.4	219.4
CF (g/day)	171.8	171.8	262.3	262.3
Threonine (g/day)	7.9	7.9	7.9	7.9
Alanine (g/day)	12.5	12.5	8.8	8.8
Valine (g/day)	12.8	12.8	11.6	11.6
Methionine (g/day)	4.9	4.9	4.0	4.0
Histidine (g/day)	6.7	6.7	4.2	4.2
Lysine (g/day)	12.5	12.5	10.2	10.2
Isoleucine (g/day)	10.8	10.8	8.7	8.7

Table 4: Body weight and growth rate of finisher ostriches from 8-9 months fed a commercial finisher diet and lucerne silage diet with and without avizyme 1302-experiment 1

Treat	Body wt (8 months) (kg)	Body wt (9 months) (kg)	Growth (8-9 months) (kg)
Diet			
Finisher	74.775	85.850a	11.075a
Finisher + Enzyme	72.425	83.450ab	11.025a
Silage	73.800	82.975ab	9.175ab
Silage + Enzyme	72.850	79.700b	6.850b
LSD (P=0.05)	NS	5.317	2.80b
Sex			
Male	74.314	83.743	9.611
Female	72.800	82.411	9.429
LSD (P=0.05)	NS	NS	NS

Mean within a column followed by a different letter are significantly different (P<0.05)

was left but by week 6 there was no wastage. Likewise for the 24% pea straw diet, 10.5 kg of pea straw was left but by the sixth week, no wastage was observed. However for the 40% pea straw diet, 38.5 kg was wasted in the first 3 weeks. Due to the low body weight gain of birds on the 40% pea straw, the property manager considered the birds were losing too much weight and changed the diet to include 0.96 kg/bird/day of the concentrate, 0.96 kg/bird day of barley and 0.64 kg/bird/day of pea straw.

Intake: The intake of pea straw was similar for ostriches on the 40% pea straw diet and 24% pea straw diet (0.34 kg vs 0.40 kg/day) and considerably lower than expected, especially for the 24% pea straw diet. This caused a very low nutrient intake for ostriches on the 40% pea straw diet (Table 7). However, the feed intake was similar for the lucerne diet and the 24% pea straw diet. The high AME intake of the lucerne diet may result from an overestimation of the AME of lucerne (8.9 MJ/kg). The commercial diet was assumed to have only 9.6 MJ AME/kg, which could be an underestimation. More importantly, the fibre intake was lower for birds on the commercial diet than those on the high fibre diets (Table 7).

Body weight and growth: Body weight and growth rate of birds on the grower and lucerne diet were significantly higher than the pea straw diets at 27 weeks (Table 8). By 30 weeks-of-age body weight of the birds on the grower diet were significantly different from the pea straw diets but not different from the lucerne diet. Growth of birds on the 40% pea straw diet was significantly lower than all the other diets. The birds were supplemented with grain and their body weight recovered to similar levels for birds fed the 24% pea straw diet (see footnote Table 8). Growth of birds over the experimental period was higher for the grower and lucerne diet

Discussion

Experiment 1-finisher ostriches: A concern in this trial was that the ostriches preferentially fed on the leaf of the silage leaving the stalk. This was a problem especially with the silage plus enzyme diet where a significant proportion of the stalk was left by the birds. The lengths of the stalks were too long for the birds to consume. Thus the daily intake of crude fibre might be overestimated. Ostriches tend to avoid fibrous and lignified grasses, preferring succulent plants (Williams *et al.*, 1993; Milton *et al.*, 1993). A critical issue when feeding higher fibre diets is to avoid impaction. This can

Table 5: Diet formulation (%) of the concentrate diet and estimated nutritive value of the lucerne, pea straw and commercial grower diets-experiment 2

Ingredient	Lucerne chaff (30%)	Pea straw (24%)	Pea straw (40%)	Commercial grower
Barley	63.93	63.59	62.17	10
Mill run				15.9
Maize				31
Oat Hulls				10.3
Pre-mix	0.36	0.33	0.42	0.35
Lucerne meal				10
Soybean meal				4.9
Canola meal (solv.)	28.57	29.18	28.33	12.5
Limestone				2
Dicalcium Phosphate				0.2
Molasses	7.14	6.63	8.33	0.5
Lysine		0.13	0.42	0.15
Methionine		0.13	0.25	0.2
Zn Bacitracin				0.03
Total	100	100	99.92	100
Estimated nutritive value				
AME (MJ/kg)	12.28	12.28	12.13	9.6
CP (%)	17.88	18.29	18.3	14.7
CF (%)	6.8	6.9	6.7	11
Methionine	0.19	0.70	0.44	0.49
Aspartic acid	1.32	1.20	1.21	1.20
Threonine	0.53	0.58	0.51	0.44
Serine	0.98	0.90	0.84	0.79
Glutamic acid	3.95	3.95	3.64	2.78
Glycine	0.68	0.77	0.69	0.60
Alanine	0.84	0.84	0.78	0.79
Valine	0.85	0.89	0.81	0.72
Isoleucine	0.60	0.62	0.63	0.56
Leucine	1.28	1.27	1.20	1.16
Tyrosine	0.57	0.48	0.52	0.49
Phenylalanine	0.83	0.76	0.76	0.66
Histidine	0.42	0.45	0.42	0.37
Lysine	0.90	1.09	1.04	0.99
Arginine	1.47	1.08	1.17	1.10

Table 6: Feed allowances of ostriches fed grower diets-experiment 2

	Lucerne chaff (30%)	Pea straw (24.6%)	Pea straw (40%)	Commercial
	Daily intake is 1.6 kg			
Concentrate	1.120	1.206	0.960	1.6
Fibre sources	0.480	0.394	0.640	

be achieved by ensuring the appropriate fibre length of 5 cm is fed to birds including a supply of stones in containers to assist the birds grind the fibre in the gizzard. If sufficient stones are abundant in the paddock a supplementary source of stones is not required. The cost of chopping silage to 5 cm lengths is considerable. In this case the decision was made to feed the silage in its natural form to reduce costs. This was ultimately found not to be desirable. Farmers will need to bear the cost of chopping fibre sources if feeding high fibre diets is to be effective.

Ostriches can digest considerable amounts of fibre including cellulose and adding Avizyme 1302 was expected to aid in breaking down ester linkages between polysaccharides and phenolics. However in this trial no benefit from including the enzyme was noted. It is difficult to understand why the addition of enzyme in the silage treatment did not improve growth rate of ostriches. While the estimation of crude fibre intake of ostriches in this treatment might have been excessive, the actual fibre intake should be higher than those on the commercial ostrich diet. Addition of enzyme should

Table 7: Estimated nutrient intake of grower ostriches from 24-30 weeks-of-age fed lucerne, pea straw and a commercial grower diet-experiment 2

Nutrient	Lucerne Chaff (30%)	Pea straw (24.6%)	Pea straw (40%)	Commercial
Intake (air dry, kg/day)	1.577	1.541	1.355	1.600
AME (MJ/kg)	17.8	15.8	12.8	15.4
CP (g/day)	272.0	239.7	198.2	235.2
CF (g/day)	200.2	240.6	248.6	89.6
Methionine (g/day)	3.2	8.8	4.6	7.9
Aspartic acid (g/day)	22.5	15.8	13.2	19.2
Threonine (g/day)	7.6	7.6	5.7	7.0
Serine (g/day)	14.1	11.9	9.3	12.6
Glutamic acid (g/day)	49.1	49.6	37.2	44.5
Glycine (g/day)	9.6	10.1	7.7	9.7
Alanine (g/day)	11.9	11.0	8.6	12.7
Valine (g/day)	12.1	11.5	8.7	11.5
Isoleucine (g/day)	8.5	8.0	6.7	8.9
Leucine (g/day)	17.3	16.3	12.7	18.6
Tyrosine (g/day)	7.6	6.1	5.4	7.9
Phenylalanine (g/day)	11.5	9.8	8.0	10.5
Histidine (g/day)	5.6	5.8	4.4	5.9
Lysine (g/day)	12.4	13.8	10.8	15.9
Arginine (g/day)	18.4	13.7	12.0	17.5

Table 8: Body weight (kg) and growth (kg) of ostriches on a commercial grower ration, lucerne and pea straw diets-experiment 2

Diet	Body wt 24 weeks	Body wt 27 weeks	Body wt 30 weeks	Growth 24-27 weeks	Growth 27-30 weeks	Growth 24-30 weeks
Commercial Grower	48.725	57.65a	62.15a	8.925a	4.50b	13.425a
Lucerne (30%)	48.550	54.325a	60.50ab	5.775ab	6.175ab	11.950a
24% Pea Straw	46.975	50.150b	55.175c	3.175b	5.025ab	8.25b
40% Pea Straw *	47.650	48.950b	55.900bc	1.30c	6.95a	8.20b
LSD (P=0.05)	NS	3.876	4.661	2.082	2.106	3.097

Means within a column followed by a different letter are significantly different (P<0.05); * the 40% pea straw diet was changed at 27 weeks to include 0.96 kg/bird/day of the concentrate, 0.96 kg/bird day of barley and 0.64 kg/bird/day of pea straw.

be beneficial to the digestion of fibre materials.

However, this was not reflected in the performance of the ostriches. The possible reasons would be the relatively short period of the trial and the large variation in growth rate between individuals within the treatment. Again, the large fermentation capability may mask the effect of enzyme because a large amount of undigested fibre can be fermented in the hindgut. The significance of the contribution of hindgut fermentation to the energy requirement for growth is unclear. More detailed studies are required.

It would be necessary in a practical situation for birds to be given a greater opportunity to adapt to the diet and for the silage to be more finely chopped so that all the silage provided was consumed. It is considered that fibre length provided to the birds was the main reason why birds on the silage diet did not consume enough feed to achieve the same growth of birds on the commercial finisher diet. The silage wasted by the ostriches was considerable and estimated to be about 60% of the total offered.

To enable cost of diets to be reduced, cheap supplementary dietary sources need to be evaluated. In the circumstance where birds forage on pasture and crop stubbles, the silage diet offers the industry the opportunity to carry out this practice and provide the silage diet as a supplementary source when forage becomes limiting in the paddock. However there will need to be a gradual introduction of birds to stubbles or pastures to ensure they adapt to the forage sources and prevent impaction. This could be achieved by gradual introduction of birds to grazing increasing to a full exposure to pasture sources after 3-4 weeks.

Experiment 2-grower ostriches: Birds consuming the pea straw diet did not grow as well as the birds on the commercial grower diet and the lucerne diet. Birds in this study (24-30) weeks-of-age found it difficult to consume the sheer volume of the pea straw. It may have been appropriate to increase the amount of concentrate offered to birds as they aged to compensate for the natural increase in food intake and energy required. When birds were switched to the respective diets it is possible that the birds on the commercial diet achieved compensatory growth in the first 3 weeks after having been fed high fibre feed in the adaptation period. Nevertheless there was evidence in the latter stages of the experiment that birds fed the 24% pea straw diet had an improvement in growth. There could be two explanations for this improvement. Firstly the growth value could be made up of a significant component of gut fill. If this were the case then there would be a need to do fasting body weights to obtain true growth, although birds were weighed on the day concentrate was unavailable. Alternatively the improvement in growth in the last 3 weeks of the experiment could be compensatory growth. It is possible the caeca and the fermentation organisms need time to adjust to the fibre source, before they become fully effective at digesting the fibre and releasing free fatty acids for absorption by the birds.

The poor performance of birds on pea straw diets might result from a high fibre intake and low AME intake. Compared with the commercial diet, the fibre intake of ostriches on pea straw treatments was 2.3-2.4 times greater than birds on the commercial diet. Dietary fibre often has a lower digestibility *per se* and also depresses the utilization of other nutrients by the birds, which has been clearly demonstrated in poultry (Acamovic, 2001). While it is clear that ostriches can digest fibre, especially in the hindgut, the utilization of the products produced during the fermentation will be incomplete. The contribution of fibre sources to energy requirement may be offset by their negative effect on the utilization of other nutrients by birds. Such negative effects also depend on the structure and source of fibers. The small difference in the performance of birds on the lucerne diet and commercial ostrich diet further demonstrates the importance of the quality of fibre sources in the ostrich diet and the potential of using fibre sources to reduce the feed cost. However, in practice, lucerne is not an ideal fibre source due to its high price and regional availability in Australia, hence the reason for assessing the pea straw diets in this experiment. It would be ideal to repeat the work and determine if the birds, even on the 40% pea straw, could adapt and eventually consume the required volume of feed to obtain the required growth rate.

Acknowledgments

The authors acknowledge the financial support for this study from the New Animal Products sub program of the Rural Industry Research and Development Corporation of Australia.

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