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# Dietary manipulation of oil production in commercial emu

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## Abstract

The aim of this research was to optimize emu oil production by manipulation of the dietary protein and energy ratios for greater fat accretion. The research was done at African Emu Ranch in Muldersdrift, Gauteng. Twenty-four, four to five months old emu birds were randomly allocated to three dietary protein treatments, namely a standard control diet containing 170 g crude protein (CP) or a 140 and 200 CP/kg diet, all with similar metabolizable energy content. Proximate analyses were done on representative samples of the diets to confirm the nutrient composition based on AOAC techniques. Water and feed were given *ad libitum.* The feeding trial spanned eight weeks. The birds were slaughtered and fat yield, anatomical and histological parameters, volatile fatty acid production and carcass weights were recorded. The fat was analyzed for lipid content and composition by means of gas chromatography. Growth rates and average weight gains of the birds in different treatments did not differ. The average dressed out carcass weights for 140, 170 and 200 g CP/kg groups were 16.75, 18.65 and 19.11 kg respectively and differed between treatments. The 200 g CP diet yielded the heaviest carcasses and highest dressing percentage. Volatile fatty acid (VFA) concentrations did not differ between dietary treatments. Acetic acid was the most abundant volatile fatty acid in the distal and proximal intestines. The highest concentration of acetic acid was found in the distal ileum. A small volume of iso-butyric acid was detected in the distal ileum. Total average fat yields for the 140, 170 and 200 g CP groups were 4.1, 4.2 and 4.4 kg respectively, but fat yields did not differ between treatments. The long-chain fatty acid composition of the fat did not differ between treatment groups and consisted of saturated fatty acids (27.74%), monounsaturated fatty acids (51.80%), and polyunsaturated fatty acids (20.45%). Fatty acid composition did not differ between different anatomical fat depots in the carcass. The total mean of lipid produced in the omental and subcutaneous locations were 82% and 92.5% respectively. The results suggest that optimum emu oil production can be achieved by feeding diets with a low protein (optimum level of 140 g) to energy ratio.

**Keywords:** Emu, nutrition, growth, protein, energy, fat yield
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## Introduction

The growing medicinal, financial and economic importance of emu oil has elevated the importance of emu production world-wide. Many American and Australian farmers are at an advanced stage of commercial emu oil production (Jefferey, 2001). South African farmers have now joined this potentially lucrative enterprise. Although emu oil production is still in its infancy, it is beset with the problems of pioneering into new territories. For example, the feeds have been adapted from the poultry (ostrich & chicken) industry in other countries where emu farming has been established. The adapted feeds may not necessarily be the appropriate feeds for emus due to climatic, environmental and other differences. Commercially acceptable emu diets would require more detailed nutritional studies based on specific nutrient requirements (Jefferey, 2001).

The thrust of this investigation was not to establish an emu diet but to study the optimal ratio of dietary protein to energy level that would result in greater fat accretion without compromising on fat quality. Anatomically, the capacity of the emu's digestive tract to handle fibre is much smaller than that of the ostrich (Minaar, 1998; Herd & Dawson, 1984). While the ostrich has some ten metres of colon, the emu has virtually no colon. This anatomical difference would suggest that the nutritional requirements of emus differ from those of ostriches (Mannion *et al.*, 1995). The aim of this research was thus to optimize emu oil production by manipulation of the dietary protein and energy ratios for greater fat accretion.

## Materials and Methods

Four to five months old emu chicks were obtained from African Emu Ranch. The birds were selected in October 2004 and had an average starting weight of 11.09 kg and were reared to approximately 30 kg as starting weight for the feeding trial. The birds were raised on the trial site so that acclimatization to the experimental facility was not a problem. All birds were identified by means of micro-chips that could be read by a scanner. A total of 26 birds were adapted on a starter diet containing 170 g crude protein (CP)/kg. This pelleted diet was fed twice per day at 1.5 – 2 kg/bird. The birds were weighed fortnightly from April 2005 to December 2005 before the feeding trial commenced.

After the adaptation period, the birds were weighed and randomly allocated to three dietary protein groups containing 140, 170 and 200 g CP/kg. The feeding trial spanned eight weeks and there were equal numbers of males and females in the treatment groups. The energy content of the diets was kept the same and the main ingredients in the diets were hominy chops, yellow maize, sunflower oil cake (SOC), wheat bran and wheat gluten. Proximate analysis of the three protein diets was performed before the trial to confirm the percentage composition of the feed from the company in respect of CP, nitrogen free extract (NFE), ether extract (EE), and crude fibre (CF) for calculation of metabolizable energy (ME) of feed samples (Table 1).

**Table 1** Proximate analysis of the three protein diets

| Treatments diets (g CP/kg) | Nutrient composition | | | | | | |
|---|---|---|---|---|---|---|---|
| | DM (g/100 g) | Moist (g/100g) | Ash (g/100g) | CP (g/100g)* | CF (g/100g) | EE (g/100g) | EME (MJ/kg) |
| "As is" basis | | | | | | | |
| Diet (140 g CP) | 90.5 | 9.5 | 8.4 | 13.2 | 7.8 | 4.6 | 12.03 |
| Diet (170 g CP) | 91.6 | 8.4 | 8.6 | 17.3 | 9.3 | 4.8 | 11.58 |
| Diet (200 g CP) | 91.1 | 8.9 | 7.7 | 20.5 | 9.2 | 4.2 | 11.58 |
| DM basis | | | | | | | |
| Diet (140 g CP) | 100 | 0 | 9.2 | 14.5 | 8.7 | 5.0 | 13.28 |
| Diet (170 g CP) | 100 | 0 | 9.4 | 18.9 | 10.1 | 5.2 | 12.47 |
| Diet (200 g CP) | 100 | 0 | 8.4 | 22.5 | 10.1 | 4.6 | 12.47 |

*The "Dumas" method was used to determine crude protein content in the feeds.
DM - Dry material; Moist – Moisture; CP - Crude protein; CF - Crude fibre; EME - Estimated metabolizable energy; EE - ether extract (crude fat).

A camp was set up on the farm for the experiment consisting of three sub-camps, passages and a weighing area for weighing the birds. All groups were fed *ad libitum* with pelleted feed and water. Fresh feed was given every morning with some additions in the afternoons when necessary during monitoring and left-overs from the previous day were collected and weighed. The atmospheric conditions with regards to temperature and humidity were presumed homogeneous in all the camps at any point in time. The birds were weighed every fortnight. At the end of the feeding trial, all the 24 birds were slaughtered at a registered abattoir, Ostrich Galore in Muldersdrift. After slaughter, the gastrointestinal contents were collected, segment by segment (proventriculus, proximal intestine, distal intestine, caeca and colon), and put in labelled plastic bottles. These were transported in a cooler box on ice and stored in a freezer at -20 ºC until extraction and analysis. For each group, the samples and observations were grouped as follows for data analysis: dressed-out carcass weight, intestinal content (volatile fatty acids and electrolytes), intestinal segments (length and weights), fat yield, and fat composition (lipid content and long-chain fatty acid composition). The fat was analyzed for lipid content and composition by means of gas chromatography (Webb *et al*., 1994). The data was analyzed by repeated measures analysis of ANOVA and the level of significance was set at $P < 0.05$. Statistical analyses were performed using SPSS version 17.0.

## Results and Discussion

The results are presented in Tables 2, 3 and 4 respectively for carcass weight and fat yield, fat composition, long chain fatty acid composition and volatile fatty acid content in the gastrointestinal tract.

With regards to carcass weight (Table 2), there was a significant difference (P <0.05) between the birds fed the different dietary protein levels. The average carcass weight was lowest in the birds fed with 140 g CP compared to those fed either 170 or 200 g CP. These results agree with that reported by Blake & Hess (2004) who found that emus fed a 180 g CP diet and similar energy content, yielded the heaviest carcasses compared to those fed either 140 g or 160 g CP diets with similar energy contents. The average fat yield of emus fed different dietary protein levels did not differ (P = 0.92; Table 2). At 12- to 15-months of age, emus weigh between 34 to 39 kg and yield between 3 to 9 kg of fat (Minnaar, 1998). Oil is usually extracted from the fat depots and the skin, rendering it useless for tanning purposes.

The lipid content of different anatomical fat locations showed a tendency towards a difference between the omental and subcutaneous fat depots (P = 0.06; Table 3). The omental and subcutaneous fat depots contained 82 and 92.5% lipid respectively. This agrees with the findings of Minnaar (1998) who found that the subcutaneous fat depot of emus always contains a greater proportion of lipid. Similar anatomical differences in lipid content were observed in bovines (Webb *et al*., 1998). The mean lipid content of the omental and subcutaneous fat in emus in this study was 87.4%.

The composition of long chain fatty acids showed no significant differences in terms of mono-unsaturated, poly-unsaturated and saturated fatty acids, between the treatment groups. In this study the proportion of polyunsaturated fatty acids was 48.4%, monounsaturated fatty acids was 29.5% and saturated fatty acids was 22.4%. These results are consistent with that of Craig-Schmidt *et al*. (1995) who reported similar results in a study on the fatty acid composition of emu oil at Auburn University. The results confirm that emu oil contains a high proportion of monounsaturated fatty acids, with lower amounts of saturated and polyunsaturated fatty acids. Oleic acid (18:1) was found to be the major monounsaturated fatty acid in emu oil, comprising over 40% of the total long-chain fatty acids. Much smaller amounts (less than 5%) of palmitoleic acid (16:1) were found. The predominant saturated fatty acids in emu oil were palmitic acid (16:1) and stearic acid (18:0) which comprised respectively 20% and 8% of the lipid content. Linoleic acid (18:2) at 20% was the predominant polyunsaturated fatty acid observed.

Approximately 70% of the fatty acids in emu fat were unsaturated. This composition is consistent with current recommendations for a “healthy heart” diet. The monounsaturated fatty acid, oleic acid, was the predominant fatty acid in emu oil. This fatty acid is a known enhancer for transport of bioactive compounds into the skin and hence the general conclusion that emu oil is very penetrating (Craig-Schmidt *et al*., 1995).

**Table 2** Carcass weight and fat yield of emus fed diets containing 140, 170 and 200 g crude protein/kg with similar energy content

| Treatment | N | Carcass weight (kg) | Variance (carcass) | P-value | Fat content (kg) | Variance (fat) | P-value |
|---|---|---|---|---|---|---|---|
| 140 | 8 | 16.75 | 1.75 | P = 0.02 | 4.05 | 0.22 | P = 0.92 |
| 170 | 8 | 18.65 | 4.05 | | 4.17 | 6.36 | |
| 200 | 7 | 19.10 | 2.65 | | 4.44 | 3.56 | |

[a,b]Means with different superscripts in the same column differed significantly (P <0.05).

**Table 3** Lipid content of emus fed diets containing 140, 170 and 200 g crude protein/kg with similar energy content

| Fat location | Dietary protein treatment (g/kg) | | | Total | Df | F | P<F |
|---|---|---|---|---|---|---|---|
| | 140 | 170 | 200 | | | | |
| Omental | 82 ± 11.97 | 83 ± 1.97 | 82 ± 0.32 | 82 ± 5.5 | 1 | 5.12 | 0.06 |
| Subcutaneous | 97 ± 0.45 | 93 ± 6.14 | 87 ± 13.4 | 93 ± 7.98 | | | |
| Total | 90 ± 11.04 | 88 ± 6.85 | 84 ± 8.4 | 87 ± 8.42 | | | |

The results of the analysis of the volatile fatty acids (Table 4) show that the differences between the percentage of the various volatile fatty acids in the distal and proximal segments of the intestine for the respective treatments did not differ significantly. Acetic acid, propionic acid, iso-butyric acid, butyric acid and valeric acid were detected in the gastrointestinal system of emu. The highest amount of the acetic acid (79.43 mM) was found in the distal intestine confirming the finding of (Herd & Dawson, 1984) that microbial fermentation of fibrous compounds in emus occurs in the distal ileum.

**Table 4** Volatile fatty acids in the gastrointestinal system of emus fed diets containing 140, 170 and 200 g crude protein/kg with similar energy content

| Volatile fatty acids | Origin | Treatment (g CP/kg) | | | Df | F | P |
|---|---|---|---|---|---|---|---|
| | | 140 | 170 | 200 | | | |
| Acetic | Distal intestine | 79.4 ± 6.94 | 68.1 ± 6.60 | 74.1 ± 6.15 | 2 | 1.291 | 0.289 |
| | Proximal intestine | 72.9 ± 12.02 | 72.9 ± 12.02 | 72.9± 12.02 | | | |
| Propionic | Distal intestine | 14.51 ± 6.03 | 23.6 ± 4.27 | 17.8 ± 7.31 | 2 | 1.723 | 0.195 |
| | Proximal intestine | 21.36 ± 9.57 | 21.6 ± 5.64 | 22.6 ± 4.51 | | | |
| Iso-butyric | Distal intestine | 0.95 ± 0.94 | 1.39 ± 0.78 | 1.29 ± 0.46 | 2 | 0.135 | 0.874 |
| | Proximal intestine | 1.32 ± 0.89 | 1.44 ± 0.89 | 1.60 ± 0.86 | | | |
| Butyric | Distal intestine | 4.51 ± 1.64 | 5.27 ± 3.58 | 5.67 ± 3.08 | 2 | 0.13 | 0.88 |
| | Proximal intestine | 3.18 ± 1.11 | 4.74 ± 2.52 | 4.32 ± 0.85 | | | |
| Valeric | Distal intestine | 0.60 ± 0.26 | 1.66 ± 0.70 | 1.15 ± 0.69 | 2 | 0.95 | 0.40 |
| | Proximal intestine | 1.31 ± 1.28 | 1.39 ± 1.03 | 1.34 ± 1.08 | | | |

## Conclusions

The results suggest that a diet with a low protein to energy ratio maximizes fat yield in commercial emu production without compromising the quality of the fat or oil. Since the cost of protein determines to a large extent feed cost, emu farmers may finish their birds more economically by feeding a lower protein diet.

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