

Preliminary results on the description of body composition change in ostriches (*Struthio camelus*) under optimal feeding conditions

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Abstract

A study was conducted to describe the changes occurring in body composition of ostriches over a 285-day growth period. Fifty two birds were given a choice of four diets with different protein (180 and 120 g/kg feed) and energy (8.5 and 13.5 MJ ME/kg feed) levels, on the assumption that the birds would select from the four feeds according to their protein and energy requirements, and thereby grow close to their potential without being constrained by the quality of feed supplied to them. Birds were weighed at approximately 10-day intervals and randomly selected birds were slaughtered at 1, 54, 120, 162 and 285 days of age respectively. Proximate analyses were done on the complete empty carcasses and the components were expressed as a percentage of live weight at the different slaughter ages. The Gompertz growth curve was fitted to the live weights of the birds and to the weights of the individual chemical components. The change in body weight with age as the only independent variable can be considered as a good ($R^2 = 0.93$) description of growth in ostriches. The growth parameters a, b and c were estimated as 119.4, 0.009 and 156.3 respectively. Body protein and moisture concentrations decreased as the birds aged, while the body ash concentration remained relatively constant and body fat concentration increased. Fitted Gompertz parameters for the different chemical components were, for fat; a = 33.6, b = 0.013 and c = 143.4 ($R^2 = 0.914$), protein; a = 44.5, b = 0.015 and c = 113.9 ($R^2 = 0.961$), ash; a = 10.3, b = 0.016 and c = 118.2 ($R^2 = 0.965$), and moisture; a = 55.0, b = 0.014 and c = 116.9 ($R^2 = 0.965$). Similar to other animals, fat was a late maturing tissue and protein a relatively early maturing tissue. These results are important in describing the growing ostrich and this information can be used to model the nutrient requirements of these birds.

Keywords: Growth, development, feeding optimization, proportional changes, Gompertz growth curve

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Introduction

An increase in size and weight is an expression of growth. Growth can usually be illustrated graphically in the form of a sigmoidal curve (McDonald *et al.*, 2002). As the animal matures, its conformation changes (Berg *et al.*, 1978). Tissues differ in the rate of maturing as dictated by survival (Berg & Butterfield, 1976). Nervous and bone tissues develop first. As the animal matures the need for muscle increases and growth of this tissue will become a priority. The slowest maturing tissue is fat and its growth rate will be at a maximum at a later stage in the growth cycle (Lawrie, 1998; McDonald *et al.*, 2002). Growth of the chemical components of the animal (protein, ash and fat), is of particular importance to nutritionists as the nutrient requirements of the animal will be dictated by this (McDonald *et al.*, 2002).

Up to now, feed formulation for ostriches has been based on principles used in the poultry industry (Cilliers, 1998; Iji *et al.*, 2003) as very little relevant research has been done with these birds to predict food intake. As the prediction of food intake for pigs and poultry is based on the characteristics of the animal involved, the assumption is made that it will be the same with ostriches. However very little, if any, research has been done on the changes in body composition of the ostrich (Brand & Gous, 2006). The presence of a large hindgut with substantial fermentative properties (Swart, 1988) complicates intake prediction. Brand *et al.* (2000) stated that 70 - 80% of the cost of producing ostriches is taken up by feeding costs. This necessitates the need for research on the nutritional requirements of ostriches and the factors that may influence these requirements.

The aim of this study was to define the potential growth of the ostrich using an appropriate growth curve and to investigate and quantify the proportional changes and growth rates of the four chemical constituents of the body.

Materials and Methods

Fifty two day-old birds (mixed) were placed in a single pen. Data were collected until slaughtering commenced. Four feeds were formulated with high and low levels of protein and energy (high energy = 13.5, low energy = 8.5 MJ/kg feed; high protein = 180, low protein = 120 g/kg feed). Subsequently the feeds were analysed (AOAC, 2002) for protein, amino acids, fat, NDF, ADF, ash, fibre and moisture (Table 1). All four feeds were offered *ad libitum* and made available simultaneously throughout the trial. Every feed combination were weighed back weekly to determine how much of each were selected (Table 2). Water was freely available throughout the trial.

Randomly selected birds (8 - 10) were weighed at approximately ten day intervals throughout the trial. Birds were slaughtered at 1, 54, 120, 162 and 285 d of age. Randomly selected birds (8 - 10) were weighed, stunned, exsanguinated and eviscerated. Blood was collected in a separate container. The intestines of each bird were cleaned with water. All body parts, along with the blood, feathers and clean intestines were frozen in plastic bags until mincing. The body as a whole was minced and one randomly selected sample (approx. 150 g) was used for protein, moisture, ash and lipid analysis (AOAC methods, 2002).

A special form of the Gompertz growth curve ($y = a*(\exp(-\exp(-b*(age-c))))$) (Emmans, 1989), was fitted to the live weight data using Statgraphics (2005). The growth parameters a, b and c were calculated for each chemical component.

Table 1 Proximate analysis of feeds (g/kg) formulated for energy and protein levels on an as is basis (high energy (HE) = 13.5 MJ/kg, high protein (HP) = 180 g/kg, low energy (LE) = 8.5 MJ/kg and low protein (LP) = 120 g/kg)

| Ingredient | HE, HP | LE, HP | HE, LP | LE, LP |
|---------------|--------|--------|--------|--------|
| Ash | 96 | 105 | 73 | 78 |
| Fibre | 77 | 204 | 108 | 214 |
| Fat | 41 | 24 | 41 | 24 |
| Crude Protein | 216 | 218 | 155 | 161 |
| ADF | 106 | 254 | 136 | 261 |
| NDF | 210 | 403 | 284 | 433 |

Table 2 Feed preference of the birds when provided with feeds differing in protein and energy in a free choice situation (high energy (HE) = 13.5 MJ/kg, high protein (HP) = 180 g/kg, low energy (LE) = 8.5 MJ/kg and low protein (LP) = 120 g/kg)

| Dietary energy (MJ ME) | Dietary protein (g/kg) | Age group (months) | | |
|---------------------------|---------------------------|--------------------|--------------|--------------|
| | | 0 – 2 (%) | 2 – 6 (%) | 6 – 9 (%) |
| HE | HP | 50.5 | 54.0 | 60.0 |
| HE | LP | 30.0 | 30.0 | 31.0 |
| LE | HP | 13.0 | 9.0 | 4.0 |
| LE | LP | 6.5 | 7.0 | 5.0 |

Results and Discussion

A free choice feeding system was used on the assumption that the birds would adjust their nutrient intake (McDonald *et al.*, 2002; Van der Merwe & Smith, 1991) such that deficiencies and excesses of protein and energy were avoided, thereby enabling the birds to grow close to their potential without being constrained by the feed offered. The feed preference of the birds is presented in Table 2. The high density diet was preferred throughout the trial. This suggests the presence of intake selection with regards to dietary energy and/or dietary protein density. The growth curve predictions (Figure 1) provide valuable information as to the potential growth rate of this strain of ostrich. The growth parameters a, b and c were estimated as 119.4, 0.009 and 156.3 respectively and will prove useful in predicting the growth of ostriches. When predicting food intake, the multiple factors influencing food intake such as temperature, nutrient density, amino acid content, stress susceptibility and general health should not be overlooked.

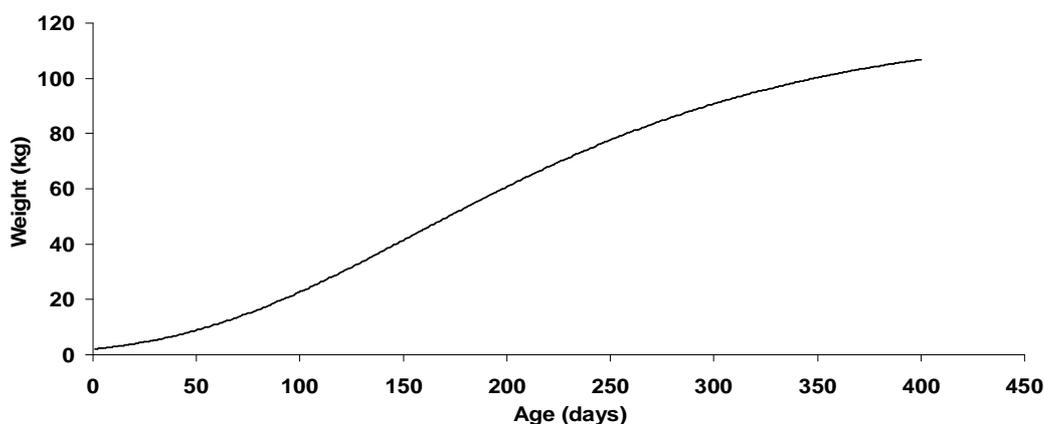


Figure 1 Gompertz growth curve fitted to ostriches offered choice diets until slaughter.

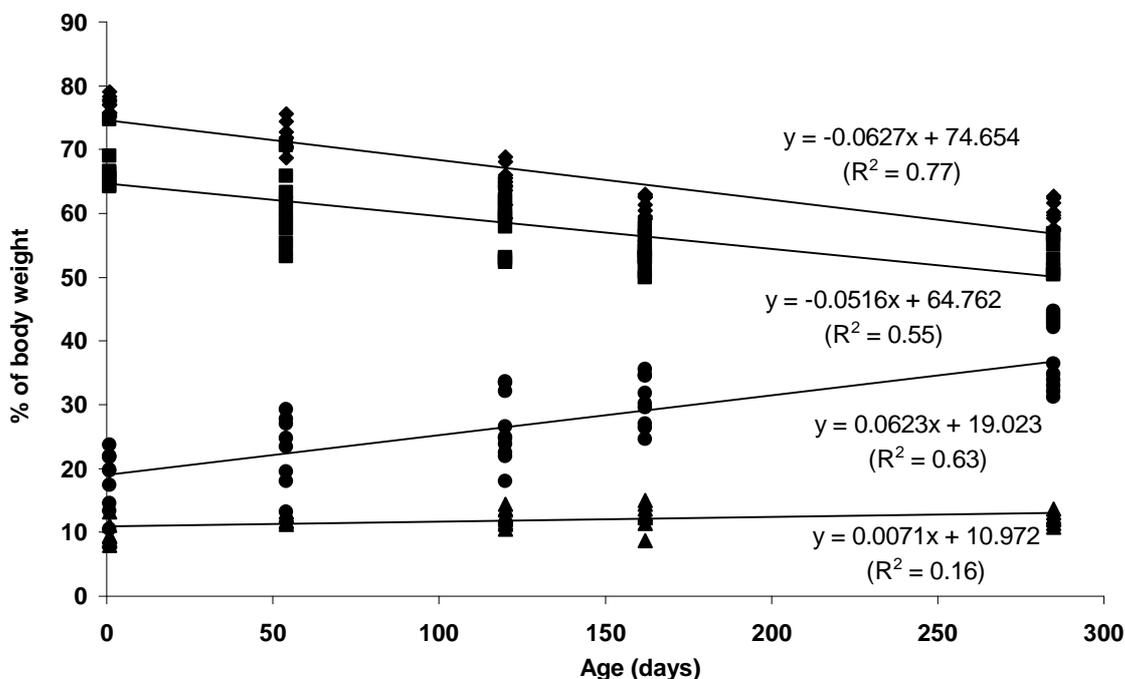


Figure 2 Linear regressions fitted to the protein (■) ash (▲) fat (●) and moisture (◆) content (% of body weight) of the body weights of ostriches serially slaughtered up till 285 days of age.

The protein and moisture contents in the body decreased linearly with an increase in age (Figure 2). This reiterates the correlation between body protein and moisture, the increase in body fat with age and the constant proportion of ash (Lawrie, 1998; McDonald *et al.*, 2002). The R²-values are high for protein, moisture and fat, but very low for ash content (R² = 0.16). The remainder of other sources of variation (60%) warrants further investigation as small pieces of bone may have confounded results.

Gompertz growth curves, fitted to the weights of each of the chemical components, are illustrated in Figure 3, while the parameter predictions describing the chemical components are set out in Table 3. The data in Table 3 confirm that the growth in the chemical deposition of components in ostriches is similar to that found in other species (Lawrie, 1998; McDonald *et al.*, 2002).

Since animals are slaughtered at intervals, repeated measurements are avoided, eliminating the correlation found in such measurements (Mellett & Randall, 1994).

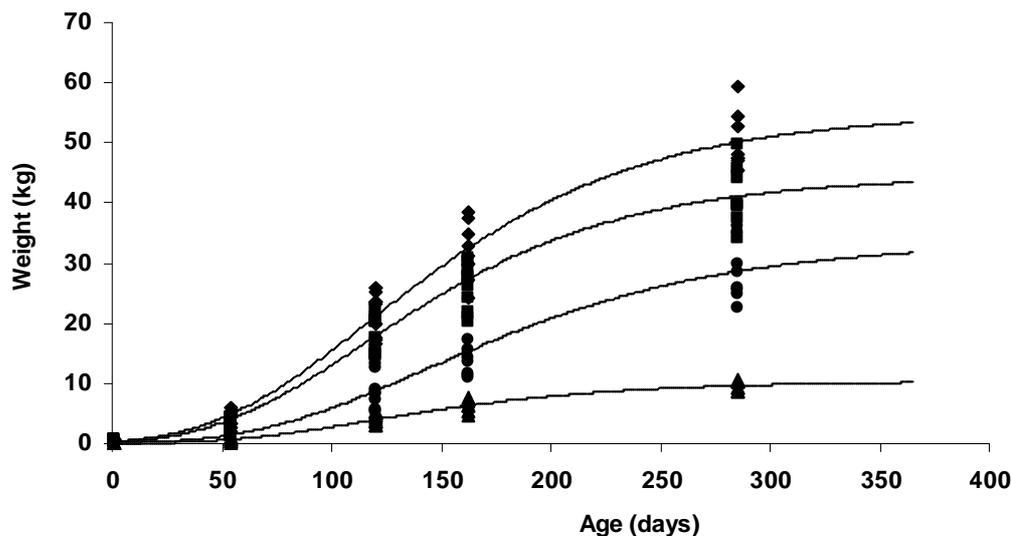


Figure 3 Gompertz growth curves fitted to protein (■) ash (▲) fat (●) and moisture (◆) weights over time.

Table 3 Growth parameters of the chemical components of the body as expressed by the Gompertz growth curve for data of serial slaughter of ostriches from 1d to 294 days of age

| | a | b | c | R ² |
|---------------|------|-------|-----|----------------|
| Ash | 10.3 | 0.016 | 118 | 0.965 |
| Moisture | 55.0 | 0.014 | 117 | 0.965 |
| Crude Protein | 44.5 | 0.015 | 114 | 0.961 |
| Fat | 33.6 | 0.013 | 143 | 0.914 |

When the body component weight was predicted (Table 3) and added, it seems that mature body weight are overestimated by approximately 20% in this study. This overestimation may be ascribed to the relatively low R²-values presented in Figure 2. Fat deposition is mostly dependent on nutrition (Ferguson, 2006) and it is reasonable to believe that fat was overestimated by the growth curve prediction. It was estimated that birds in this study gained weight at a maximum rate by day 156; mature mass was predicted at 119.4 kg and the estimated rate of maturing parameter at 0.009. This compares well with the study of Du Preez *et al.* (1992), who found that under *ad libitum* feeding, maximum daily weight gain occurred at 92 - 114 d for Zimbabwean birds, 115-124 d for Namibian birds and 163 - 175 d for South African birds. The predicted mature weights were found to be 94.2 - 104.9 (Zimbabwean), 92.6 - 99.6 (Namibian), 98.4 - 102.1

kg (South African), and rate of maturing parameters of 0.0138 - 0.0168 (Zimbabwean), 0.0126 - 0.0135 (Namibian) and 0.0090 - 0.0097 (South African), respectively.

Conclusion

Assuming that ostriches will select feed according to protein and energy requirements and thereby grow close to their potential, without being constrained by the quality of feed supplied to them, the results presented here could be regarded as representing the potential growth rate of this particular strain of ostrich. Protein was shown to be an early maturing tissue and fat as relatively late maturing. This serves as confirmation that the chemical components of the ostrich increase in similar ways to those in other animal/bird species. Each chemical component was described by a Gompertz growth curve, this being useful when modeling the nutrient requirements of ostriches during different periods in their production cycle. Additional studies will also be done to improve the accuracy of the prediction parameters for the different body constituents. The next step is to predict voluntary food intake, which would assist in defining the concentration of nutrients to be specified in a feed formulation program more accurately than is the case at present (Gous & Fisher, 2008). Only thereafter will it become possible to optimize feeding regimes for ostriches.

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