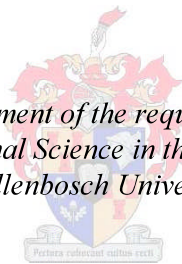


**Studies to develop a mathematical
optimisation model to describe the effect of
nutrition on the growth of ostriches (*Struthio
camelus* var. *domesticus*)**

by
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*Thesis presented in fulfilment of the requirements for the degree of
Master of Science in Animal Science in the Faculty of AgriScience at
Stellenbosch University*



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Declaration

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to be extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any other qualification.

Date: December 2013

Note

The language and style used in this thesis are in accordance with the requirements of British Poultry Science. This thesis represents a compilation of manuscripts where each chapter is an individual entity and some repetitions between the chapters have therefore been unavoidable. It should be noted that each chapter has its own reference list instead of one comprehensive list appearing at the end of the thesis.

The following contributions arising from this study have been presented at the South African Society for Animal Science congresses:

BRAND, T.S., CARSTENS, P.D., KRITZINGER, W.J., HOFFMAN, L.C. & GOUS, R.M. (2012) The effect of dietary bulk density on the feed intake of ostrich chicks (*Struthio camelus var. domesticus*) Book of abstracts, *South African Journal of Animal Science Congress*. pp.126. East London.

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CARSTENS, P.D., BRAND, T.S. & HOFFMAN, L.C. (2013) The effect of dietary protein and amino acid concentration on certain production parameters of growing ostrich chicks (*Struthio camelus var. domesticus*) Book of abstracts, *South African Journal of Animal Science Congress*. pp.19. Bloemfontein.

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Table of contents

Declaration	ii
Note.....	iii
Acknowledgements.....	iv
Table of contents.....	vi
Abstract	vii
Opsomming.....	ix
 CHAPTER 1: General Introduction.....	 1
 CHAPTER 2: Literature review.....	 3
 CHAPTER 3: The growth response of ostrich (<i>Struthio camelus</i> var. <i>domesticus</i>) chicks fed diets with three different dietary protein and amino acid levels	 34
 CHAPTER 4: The effect of dietary bulk density of the feed intake of slaughter ostriches (<i>Struthio camelus</i> var. <i>domesticus</i>)	 51
 CHAPTER 5: The effect of dietary protein concentrations on production parameters of ostrich chicks	 66
 CHAPTER 6: The effect of dietary energy concentrations on production parameters of ostrich chicks (<i>Struthio camelus</i> var. <i>domesticus</i>).....	 89
 CHAPTER 7: The effect of feather clipping on production parameters of ostrich (<i>Struthio camelus</i> var. <i>domesticus</i>)	 117
 CHAPTER 8: General conclusions	 146

Abstract

The first study (Chapter 3) evaluated the growth response of ostrich chicks on diets containing three different levels of protein and amino acids. Linear and nonlinear models were fitted to the data and compared by using Akaike's information criterion (AIC). The linear polynomial of the third degree had the lowest AIC value for all three treatments thus making it the most suitable model for the data. Significant differences were found between treatments for growth data. The results from this study can aid in describing the growth of ostriches subjected to assumed optimum feeding conditions.

In the second study (Chapter 4), a range of diets was formulated for the five growth stages of ostriches (pre-starter, starter, grower, finisher and maintenance) according to their nutrient requirements. The diets were diluted with wheat straw. Three dilution levels (0%, 10% and 20%) were used for the pre-starter and starter phases, five dilution levels (0%, 15%, 30%, 45% and 60%) were used for the grower and the finisher phases, and five dilution levels (0%, 20%, 40%, 60% and 80%) were used for the maintenance phase. Weekly intake data were collected throughout each phase. Feed bulk restricted intake by 21% and 52% at the 10% and 20% dilution level, respectively ($P < 0.05$) in the pre-starter phase, whereas intake was not restricted during the starter phase ($P > 0.05$). Intake was constrained by 39% and 42% at the 45% and 60% dilution levels in the grower phase, respectively ($P < 0.05$), and by 17% and 39% at the 45% and 60% dilution levels ($P < 0.05$) in the finisher phase, respectively. Feed bulk restricted intake by 60% and 69% for the 60% and 80% dilution levels ($P < 0.05$), respectively, in the maintenance phase. Defining the bulk density that will constrain feed intake, as established in this study, will aid in least-cost feed formulations, feed intake modelling and growth predictions.

In the third study (Chapter 5) the effect of three different dietary protein (with a specific associated amino acid content) concentrations on certain production parameters in growing ostriches were investigated. Significant differences were found for the final live weight of birds, cold carcass weight, thigh weight as well as for most of the weighed muscles at slaughter (350 days old). Concerning the growth and feed related parameters, only average daily gain (ADG) was influenced by dietary treatment ($P < 0.05$). Results indicated that birds on the diet with the medium protein performed optimally. One exception is the starter phase (26 – 47 kg) where chicks on the high protein diet outperformed those on the medium protein diet.

In the fourth study (Chapter 6) the effects of different dietary energy concentrations on ostrich production parameters were examined in two different trials. The first trial included measurements from the pre-starter phase through the starter phase until the grower phase. The second trial was based on the finisher phase *per se*. Overall dietary levels provided in the pre-starter, starter and grower phases indicated better growth, FCR, skin size and grade, thigh weight, live weight, and carcass weight for the birds fed the medium energy diet. Dietary energy levels provided during the finisher phase indicated that the energy level above the medium level used improved growth rate and tanned skin size. The gender of the birds influenced carcass weight, growth rate, and certain feather parameters ($P < 0.05$).

In the fifth study (Chapter 7) the effect of feather clipping at six to eight months of age on the production parameters of ostrich chicks were investigated. The study was conducted in three different trials. In each of the trials the feathers of half the amount of birds were clipped at six to eight months of age. Significant differences ($P < 0.05$) were found for the feed conversion ratio (FCR), the average daily gain (ADG) and for the quantity of valuable feathers. Results indicated that the growth rate and FCR was better for the birds which had their feathers clipped at six to eight months of age. Results also showed that the quantity of feathers with commercial value were significantly higher for the clipped group.

This study showed that there may be an advantage for ostrich producers concerning the harvesting of feathers at six to eight months of age.

The work in this thesis is a follow up on the framework set by Kritzinger (2011) and is part of the same project. Most of the results obtained in these studies will be incorporated in to the mathematical optimisation model of Gous and Brand (2008) for more accurate predictions concerning feed intake and other production parameters that may lower feeding costs.

Opsomming

Die eerste studie (Hoofstuk 3) evalueer die groei van volstruiskuike op diëte met drie verskillende vlakke van proteïene en aminosure. Liniêre en nie-liniêre regressiemodelle is op die data gepas en met Akaike se inligting kriterium (AIC) vergelyk. Die liniêre polinoom van die derde graad het die laagste AIC waarde vir al drie behandelings gehad. Daarom is die voorspellings van hierdie model gebruik om die groeidata te interpreteer. Beduidende verskille tussen behandelings vir groeidata ($P < 0.05$) is gevind. Die resultate van hierdie studie kan help met die beskrywing van die groei van volstruise, onderworpe aan aangeneemde optimale voedingsbehoefte.

In die tweede studie (Hoofstuk 4) is 'n verskeidenheid diëte geformuleer vir die vyf groeistadiums van volstruise (voor-aanvangs, aanvangs, groei, afronding en onderhoud) volgens hul voedingsbehoefte. Die diëte is verdun met koringstrooi. Drie verdunningsvlakke (0%, 10% en 20%) is gebruik vir die voor-aanvangs- en aanvangsfase, vyf verdunningsvlakke (0%, 15%, 30%, 45% en 60%) is gebruik vir die groei- en die afrondingsfase en vyf verdunningsvlakke (0%, 20%, 40%, 60% en 80%) is gebruik vir die onderhoudsfase. Weeklikse inname-data is ingesamel gedurende elke fase. In die voor-aanvangsfase het voerlywigheid (verhoging van ruvesel) inname beperk met 21% en 52% vir die 10% en 20% verdunningsvlakke ($P < 0.05$) onderskeidelik, terwyl inname nie beperk is gedurende die aanvangsfase nie ($P > 0.05$). Inname is beperk met 39% en 42% op die 45% en 60% verdunningsvlakke in die groeifase ($P < 0.05$) onderskeidelik, en met 17% en 39% op die 45% en 60% verdunningsvlakke in die afrondingsfase ($P < 0.05$), onderskeidelik. Voerdigtheid het inname beperk met 60% en 69% vir die 60% en 80% verdunningsvlakke, onderskeidelik, in die onderhoudsfase ($P < 0.05$). Die definiëring van die digtheid of ruvoerinhoud van voer wat inname beperk, soos in die studie bepaal, sal help met die optimering van voerformulasies, voerinname-modellering en groeivoorspellings.

In die derde studie (Hoofstuk 5) is die effek van drie verskillende dieëtproteïenkonsentrasies (met 'n spesifieke gepaardgaande aminosuurinhoud) op sekere produksieparameters in die groei van volstruise ondersoek. Beduidende verskille is gevind vir die finale lewende gewig, koue karkasmassa, boudgewig sowel as vir die meeste van die geweegde spiere van voëls op slagouderdom (350 dae oud). Met betrekking tot die groei en voedingsverwante parameters, is slegs die gemiddelde daaglikse toename (GDT) beïnvloed deur die diëet ($P < 0.05$). Resultate het aangedui dat voëls op die medium-proteïendiëet

optimaal presteer. Een uitsondering is die aanvangsfase (26 – 47 kg), waar kuikens op die hoë-proteïendieet beter gevaar het as die voëls wat die medium-proteïendieet ontvang het.

In die vierde studie (Hoofstuk 6) is die invloed van verskillende dieet-energie-konsentrasies op volstruis-produksieparameters in twee verskillende proewe ondersoek. Die eerste proef het gestrek vanaf die voor-aanvangsfase, deur die aanvangsfase tot en met die einde van die groeifase. Die tweede proef is gedoen vir die afrondingsfase.

In die voor-aanvangs-, aanvangs- en groeifase is beter groei, voeromsetverhouding (VOV), velgrootte en -graad, boudgewig, lewende gewig en karkasgewig verkry vir die voëls wat die standaard-energie dieet ontvang het ($P < 0.05$). Dieet-energievlakke wat tydens die afrondingsfase fase verskaf is, het aangedui dat die energievlak bo die medium-vlak verbeterde groeitempo en gelooide velgrootte tot gevolg het ($P < 0.05$). Die geslag van die voëls het 'n invloed gehad op karkasgewig, groei, en sekere veerparameters.

In die vyfde studie (Hoofstuk 7) is die effek van die knip van vere, op die ouderdom van ses tot agt maande, op die produksieparameters van volstruis kuikens ondersoek. Die studie is uitgevoer in drie verskillende proewe. In elk van die proewe is die vere van die helfte van die hoeveelheid voëls geknip op ses tot agt maande ouderdom. Beduidende verskille is gevind vir die VOV, die gemiddelde daaglikse toename (GDT) en vir die hoeveelheid waardevolle vere ($P < 0.05$). Die groeitempo en VOV was beter vir die voëls waarvan die vere op ses tot agt maande ouderdom geknip is ($P < 0.05$). Resultate het ook getoon dat die hoeveelheid waardevolle vere aansienlik hoër was vir die groep waarvan die vere op ses tot agt maande ouderdom geknip is ($P < 0.05$). Hierdie studie het getoon dat daar 'n voordeel mag wees vir volstruisprodusente indien vere geknip word op die ouderdom van ses tot agt maande.

Die werk in hierdie tesis volg op die raamwerk van Kritzinger (2011) en was deel van dieselfde projek. Die meeste van die resultate wat verkry is in die studies sal in die wiskundige optimeringsmodel van Gous en Brand (2008) geïnkorporeer word vir meer akkurate voorspellings van voerinname en produksieparameters wat die voerkostes kan verlaag.