

Evaluation of phytase enzymes on performance, bone mineralisation, carcass characteristics and small intestinal morphology of broilers fed maize soya bean diets

by

Liesel van Emmenes

*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*



Supervisor: Dr E Pieterse
Co-supervisor: Prof LC Hoffman

April 2014

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 the 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 qualification.

Date: April 2014

Summary

The use of phytase enzymes to liberate phosphorus and other phytate bound nutrients in monogastric animal diets are becoming common practice and several commercial phytase enzymes are available on the market. Phytase manufacturers supply nutritionists with matrix values for the specific phytase, enabling nutritionists to effectively decrease the dietary concentrations of phosphorus and nutrients during diet formulation. A 32 day experiment was conducted with 5120 broiler chicks fed diets supplemented with different commercial phytase enzymes (1000 FYT or 1500 FYT HiPhos/kg diet, 1500 FYT Ronozyme/kg diet, 500 FTU Natuphos/kg diet or 500 FTU Phyzyme/kg diet) at levels recommended by the manufacturers and with similar phosphorus equivalence. The nutrient content of the diets supplemented with 500 FTU Natuphos, 500 FTU Phyzyme 1500 Ronozyme and 1000 FYT HiPhos were reduced according to the matrix values of 1000 FYT/kg HiPhos, whilst the diet supplemented with 1500 FYT HiPhos /kg diet was reduced according to the matrix values 1500 FYT HiPhos. The objectives of this study were threefold: (i) to confirm the matrix value for a newly developed phytase (HiPhos, DSM Nutritional Products, Basel, Switzerland), at two different inclusion levels, using weight gain and bone parameters of broilers as response criteria; (ii) to compare production and bone parameters of broilers reared on three different commercial phytases to broilers reared on HiPhos (iii) to investigate the effect that supplementation of these four phytases has on water intake, carcass characteristics, organ weights and gastrointestinal tract morphology of broilers. The matrix values for 1500 FYT HiPhos were confirmed by using live weight gain as response criteria, but results for bone parameters were insufficient in confirming the matrix values. The matrix values for 1000 FYT HiPhos were confirmed by the results for tibia weight and tibia strength, but results for weight gain were insufficient to confirm the values. The matrix values for 1000 FYT HiPhos and 1500 FYT HiPhos could not be confirmed nor disproved, nevertheless results from the current trial proved diets supplemented with HiPhos to be more economically viable when compared to the standard commercial broiler diet. Total feed and water intake were not influenced by phytase supplementation. Production parameters (live weight, feed intake, feed conversion ratio, European production efficiency factor and average daily gain) and bone parameters (tibia strength, fat free tibia weight, fat free tibia ash and mineral content) did not differ between phytase treatments and therefore all the commercial phytases were equally effective to the HiPhos phytase. Furthermore, results indicate that the investigated phytases had no effect on internal organ weight or gastrointestinal tract morphology in broilers. Overall the results obtained from the study indicate that the use of phytase as feed additive has no negative effects on growth performance, carcass characteristics or bone parameters. No major differences for the production and bone parameters were observed between broilers supplemented with different phytases. Therefore the costs of these phytases can be the determining factor when nutritionists decide which commercial phytase to use.

Opsomming

Die gebruik van fitase ensieme in die diëte van enkelmaagdiere om fitaat-gebonde fosfor en voedingstowwe vry te stel, word al hoe meer algemeen in die bedryf en verskeie kommersiële fitase ensieme is in die mark beskikbaar. Die ensiemvervaardigers verskaf die fitases se matryswaardes aan voedingkundiges wat hul in staat stel om die fosfor- en nutrientvlakke in die dieet effektief te verminder. 'n Studie met 5120 braaikuikens was vir 32 dae uitgevoer. Die braaikuiken diëte was met verskillende kommersiële fitase ensieme (1000 FYT & 1500 FYT HiPhos/kg dieet, 1500 FYT Ronozyme/kg dieet, 500 FTU Natuphos/kg dieet of 500 FTU Phyzyme/kg dieet) aangevul. Die nutrientvlakke van die diëte wat met fitase aangevul was, was verminder volgens die matryswaardes van 1000 FYT of 1500 FYT HiPhos fitase. Die doelstellings van hierdie studie was drievoudig: (i) om die matryswaardes van 'n nuwe fitase (HiPhos, DSM Nutritional Products, Basel, Switzerland) by twee verskillende insluitingsvlakke te bevestig deur massa toename en been parameters as reaksie maatstawwe te gebruik (ii) om produksie- en been parameters van braaikuikens, wat een van drie kommersiële fitase ensieme as voerbymiddel ontvang het, met dié van braaikuikens wat die nuwe ensiem gevoer was te vergelyk (iii) om die effek wat fitase op water inname, karkaseienskappe, orgaan massas en spysverteringskanaal morfologie het te bestudeer. Die matryswaardes vir 1500 FYT HiPhos was bevestig deur lewendige massa toename as respons kriteria te gebruik, maar resultate vir die been parameters was onvoldoende om die matryswaardes te bevestig. Die matryswaardes vir 1000 FYT HiPhos was slegs bevestig deur die resultate vir die breeksterktes van die tibias, maar resultate vir massa toename was onvoldoende om die matryswaardes te bevestig. Dus kon die matryswaardes vir die HiPhos fitase nie bevestig of verkeerd bewys word nie. Desondanks het die resultate in die huidige proef bewys dat diëte wat met HiPhos aangevul was meer ekonomies as die kommersiële braaikuiken dieet is. Totale voer- en water-inname was nie deur die aanvulling van fitase beïnvloed nie. Produksie parameters (lewendige massa, voeromset, die Europese produksie doeltreffendheids faktor, gemiddelde daaglikse toename) en been parameters (tibia breeksterkte, vet vrye tibia massa, vet vrye tibia as en mineraal-inhoud) het nie verskil tussen die fitase behandelings nie en dus was al die kommersiële fitases ewe effektief. Vanuit die studie is getoon dat die gebruik van fitase as 'n voerbymiddels geen negatiewe effek op groei, karkas eienskappe of been parameters het nie en dat fitase ook nie die orgaan gewigte of die spysverteringskanaal morfologie van braaikuikens beïnvloed nie. Geen groot verskille in produksie- en been parameters was waargeneem tussen hoenders wat verskillende fitases as voerbymiddel ontvang het nie, daarom kan die koste van die ensiem die bepalende faktor wees as voedingkundiges die keuse maak tussen hierdie kommersiële fitases.

Acknowledgements

On the completion of this thesis, I would like to express my sincerest appreciation and gratitude to the following people, without whom this work would have never been possible.

First and foremost, I am grateful to my Heavenly Father, to whom I owe my very existence and all I have achieved in life. Without him, none of these things would have been possible.

Special thanks to Dr Elsje Pieterse, my supervisor, for her continued support, guidance, advice, humour and laughter, as well as to her family for their willingness to help late nights and weekends.

DSM for providing financial support for the trial.

Special thanks to the National Research Foundation (**NRF**) of South Africa and the Protein Research Foundation (**PRF**) who provided the financial support for my post-graduate studies.

Francois Nell and Gerrit Ferreira for all your help and patiently answering all my questions.

Dino for all your help in the poultry house and for always handling all my chickens with love and care.

Elaine for all your help and advice.

Gail Jordaan for your assistance with the statistical analysis.

Prof Hoffman for your advice and guidance.

The staff members of the Department of Animal Sciences for your assistance throughout the study.

Thanks to all the post graduate students for all your help and the “Narga Team” for all the tea breaks, motivational chats, laughs and all the fun times we had together.

Annemie who I kindly forced to help me, but I know you did it with a smile.

Junita, for helping me in times of need and always being there when I needed you. You are a true friend. Thank you.

My siblings, Roelien and Johan, for your love, support and encouragement.

Last but not least to my parents, Liesie and Roelfie, for raising us in a loving home, always setting a good example for your children and supporting me and all the choices I make. I love you.

Notes

The language and style used in this thesis are in accordance with the requirements of the *South African Journal of Animal Science*. This thesis represents a compilation of manuscripts where each chapter is an individual entity and some repetition between chapters is therefore unavoidable.