

Aus dem Institut für Agrar- und Ernährungswissenschaften
(Geschäftsführender Direktor: Prof. Dr. M. Rodehutschord)
der
Naturwissenschaftliche Fakultät III-
Agrarwissenschaften, Geowissenschaften, Mathematik und Informatik
der
Martin-Luther-Universität
Halle-Wittenberg



**Standardisation of precaecal and total tract amino acid
digestibility measurement in laying hens**

Dissertation
Zur Erlangung des akademischen Grades
doctor agriculturarum (Dr. agr.)

vorgelegt von

M.Sc. Agraringenieur

Mohammad Reza Rezvani

geb. am 01.09.1971

in Neyshaboor – Iran

Gutachter: Prof. Dr. M. Rodehutschord

Prof. Dr. E. von Borell

Prof. Dr. C. Wenk

Dekan: Prof. Dr. P. Wycisk

Verteidigung am: 02.07.2007

Halle/Saale 2007

urn:nbn:de:gbv:3-000012186

[<http://nbn-resolving.de/urn/resolver.pl?urn=nbn%3Ade%3Agbv%3A3-000012186>]

Berichte aus der Agrarwissenschaft

Mohammad Reza Rezvani

**Standardisation of precaecal and total tract amino acid
digestibility measurement in laying hens**

Shaker Verlag

Aachen 2007

Bibliographie information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche
Nationalbibliografie; detailed bibliographie data are available in the Internet
at <http://dnb.d-nb.de>.

Zugl.: Halle, Univ., Diss., 2007

Copyright Shaker Verlag 2007

All rights reserved. No part of this publication may be reproduced, stored in a
retrieval system, or transmitted, in any form or by any means, electronic,
mechanical, photocopying, recording or otherwise, without the
prior permission of the publishers.

Printed in Germany.

ISBN 978-3-8322-6412-3

ISSN 0945-0653

Shaker Verlag GmbH • P.O. BOX 101818. D-52018 Aachen

Phone: 0049/2407/9596-0 • Telefax: 0049/2407/9596-9

Internet: www.shaker.de • e-mail: info@shaker.de

Contents	Page
List of Tables	III
List of Figures	V
Abbreviations	VI
1. Introduction	1
2. Current State of Knowledge – Literature Review	2
2.1. Total tract and precaecal digestibility	3
2.1.1. Total tract sampling	3
2.1.2. Total tract excreta collection in intact poultry	3
2.1.2.1. Total tract excreta collection in caeectomised poultry	4
2.1.2.2. Total tract faeces collection in caeectomised and colostomised poultry	6
2.1.3. Precaecal sampling	7
2.1.3.1. Precaecal digesta collection after poultry slaughtering	9
2.1.3.2. Precaecal digesta collection after cannulation	10
2.2. True and apparent digestibility	11
2.3. Assay method	13
2.4. Factors affecting digestibility measurements	17
3. Own Work	19
3.1. Objectives of the own work	19
3.2. Experiment 1. Effect of ileum segment and protein source on net disappearance of crude protein and amino acids from the ileum of laying hens	20
3.2.1. Introduction	20
3.2.2. Materials and methods	21
3.2.3. Results	27
3.2.4. Discussion	33
3.2.5. Conclusion	36
3.3. Experiment 2. Partial precaecal digestibility of amino acids for toasted soybeans and maize gluten	37
3.3.1. Introduction	37
3.3.2. Materials and methods	38
3.3.3. Results	42
3.3.4. Discussion	47
3.3.5. Conclusion	49

3.4.	Experiment 3. Comparison of unexcreted proportion of amino acid and nitrogen and energy metabolisability for diet between intact and caeectomised laying hens.....	50
3.5.1.	Introduction.....	50
3.5.2.	Materials and methods.....	51
3.5.3.	Results.....	55
3.5.4.	Discussion.....	57
3.5.5.	Conclusion.....	58
3.6.	Experiment 4. Amino acid excretion in caeectomised laying hens of different ages.....	60
3.6.1.	Introduction.....	60
3.6.2.	Materials and methods.....	60
3.6.3.	Results.....	62
3.6.4.	Discussion.....	64
3.6.5.	Conclusion.....	65
3.7.	Experiment 5. Marker transit time in the gastrointestinal tract of caeectomised laying hens.....	66
3.7.1.	Introduction.....	66
3.7.2.	Materials and methods.....	67
3.7.3.	Results.....	68
3.7.4.	Discussion.....	69
3.7.5.	Conclusion.....	69
3.8.	Experiment 6. Total tract digestibility of amino acids for toasted soybeans and maize gluten in caeectomised laying hens.....	70
3.8.1.	Introduction.....	70
3.8.2.	Materials and methods.....	71
3.8.3.	Results.....	74
3.8.4.	Discussion.....	82
3.8.5.	Conclusion.....	84
4.	General Discussion and Conclusion	85
5.	Outlook	92
6.	Summary	93
7.	Zusammenfassung	96
	References.....	100
	Appendices.....	113

List of Tables	page
Table 3-1. Composition of experimental diets in Experiment 1	22
Table 3-2. Analysed concentrations of proximate nutrients and amino acids in the experimental diets, pure soybean meal and rapeseed meal used in Experiment 1	23
Table 3-3. Hen performance data in Experiment 1	29
Table 3-4. Net disappearance of crude protein and amino acid determined in the proximal, central and terminal sub-section of gut in laying hen fed a basal diet and other diets with different inclusion rates of soybean meal and rapeseed meal in Experiment 1	30
Table 3-5. Partial precaecal net disappearance of amino acids and crude protein for soybean meal and rapeseed meal in three sub-sections of gut in laying hen determined by multiple linear regression analysis in Experiment 1	32
Table 3-6. Partial precaecal digestibility of amino acids and crude protein (pooled data from central and terminal sub-sections of gut) for soybean meal and rapeseed meal determined by multiple linear regression analysis in Experiment 1	33
Table 3-7. Composition of experimental diets in Experiment 2	38
Table 3-8. Analysed concentrations of proximate nutrients and amino acids in the experimental diets, pure toasted soybeans and maize gluten used in Experiment 2	39
Table 3-9. Hen performance data in Experiment 2	44
Table 3-10. Digestibility coefficient of amino acids and nitrogen for the basal diet and the other diets with different inclusion rates of toasted soybeans and maize gluten in Experiment 2	45
Table 3-11. Partial precaecal digestibility of amino acids and nitrogen for toasted soybeans and maize gluten determined by multiple linear regression analysis in Experiment 2	47
Table 3-12. Diet composition in Experiments 3, 4 and 5	53
Table 3-13. Chemical analyses of the experimental diet used in experiments 3, 4 and 5	54
Table 3-14. Comparison between caectomised and intact laying hens for production performance in Experiment 3	56

Table 3-15. Comparison of unexcreted proportion of dry matter, nitrogen and amino acids and energy metabolisability for diet between caeectomised and intact hens in Experiment 3.....	57
Table 3-16. Production performance of caeectomised hens at different ages in Experiment 4.....	62
Table 3-17. Comparison of unexcreted proportion of dry matter, nitrogen and amino acids and energy metabolisability for diet between different ages in Experiment 4.....	63
Table 3-18. Experimental diet distribution during three excreta collection periods in Experiment 6.....	72
Table 3-19. Hen performance data in Experiment 6.....	77
Table 3-20. Unexcreted proportions of amino acids and nitrogen for the basal diet and the other diets with different inclusion rates of toasted soybeans and maize gluten used in Experiment 6.....	78
Table 3-21. Comparison of unexcreted proportion of amino acids and nitrogen between marker and total excreta calculation method in Experiment 6.....	79
Table 3-22. Partial total tract digestibility of amino acids and nitrogen for toasted soybeans and maize gluten based on marker calculation and determined by multiple linear regression analysis in Experiment 6.....	81
Table 3-23. Partial total tract digestibility of the amino acids and nitrogen for toasted soybeans and maize gluten based on total excreta collection calculation and determined by multiple linear regression analysis in Experiment 6.....	82
Table 4-1. Comparison between digestibility coefficient and unexcreted proportion of amino acid and nitrogen for diet calculated based on marker in Experiments 2 and 6.....	88
Table 4-2. Comparison between partial precaecal digestibility and partial total tract digestibility for toasted soybeans, calculated based on marker and determined by simple linear independent regression analysis in Experiments 2 and 6.....	89
Table 4-3. Comparison between partial precaecal digestibility and partial total tract digestibility for maize gluten, calculated based on marker and determined by simple linear independent regression analysis in Experiments 2 and 6.....	90

List of Figures	page
Figure 1-1. Schematic diagram depicting the stages of digestion, absorption and metabolism of ingested protein in animals.....	2
Figure 2-1. Diagram showing poultry gastrointestinal tract.....	3
Figure 2-2. Diagram of lower intestine of the domestic fowl.....	7
Figure 2-3. Schematic representation of amino acid utilization in growing pigs.....	12
Figure 3-1. Graph showing relationship between intake and digested amount of crude protein, lysine and methionine up to the terminal ileum in laying hens fed on different dietary concentration of rapeseed meal and soybean meal in Experiment 1	31
Figure 3-2. Graph showing relationship between intake and digested amount of nitrogen, lysine and methionine up to the terminal ileum in laying hens fed on different dietary concentration of toasted soybeans and maize gluten in Experiment 2.....	46
Figure 3-3. Photograph showing caecectomy surgery done for Experiments 3, 4, 5 and 6.....	52
Figure 3-4. Graph detailing TiO ₂ concentration in excreta following TiO ₂ withdrawal from the diet in Experiment 5.....	68
Figure 3-5. Graph showing relationship between intake and unexcreted amount of nitrogen, lysine and methionine in laying hens fed on different dietary concentration of toasted soybeans and maize gluten in Experiment 6.....	80
Figure 4-1. Graph showing relationship between intake and digested amounts of methionine from toasted soybeans and maize gluten, determined precaecally or based on total tract method in Experiments 2 and 6.....	91
Figure 4-2. Graph showing standard error of amino acid digestibility measurements in precaecal and total tract method for toasted soybeans and maize gluten in Experiments 2 and 6.....	91

Abbreviations

Apart from the common SI-units, the following abbreviations appear in the text:

AA or AAs	Amino acid or amino acids
AAAD	Apparent amino acid digestibility
ANF	Anti-nutritive factor
BW	Body weight
CP	Crude protein
DM	Dry matter
EAA	Endogenous amino acid
EM	Energy metabolisability
EP	Egg production
EW	Egg weight
FI	Feed intake
GIT	Gastro-intestinal tract
HPLC	High performance liquid chromatography
ICCJ	Ileo-caeca-colonic junction
IL	Ileum length
MD	Meckel's diverticulum
MG	Maize gluten
ND	Net disappearance
PC	Precaecal
PD	Partial digestibility
PPD	Partial precaecal digestibility
PTD	Partial total tract digestibility
RM	Rapeseed meal
SM	Soybean meal
TAAD	True amino acid digestibility
TS	Toasted soybeans
TT	Total tract
UP	Unexcreted proportion