



NUTRITIONAL EVALUATION BY PDCAAS AND DIAAS OF INSECT PROTEIN IN RATS AND PIGS

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- > PDCAAS exp. was part of MSc thesis by Line Dinesen Jensen
- > Work online @ JIFF

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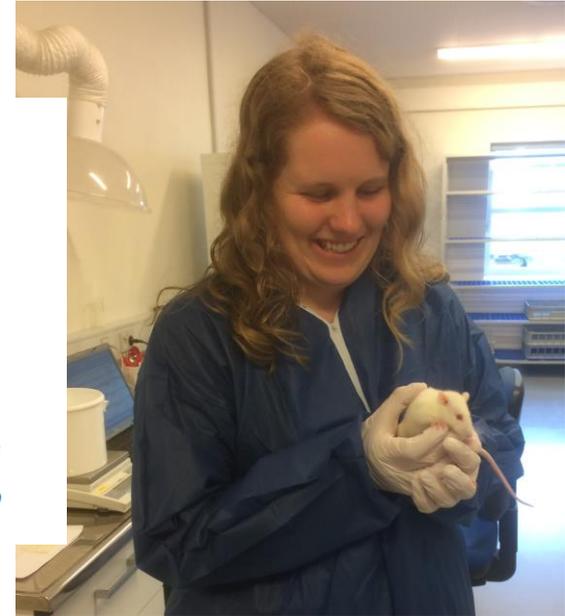
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Nutritional evaluation of common (*Tenebrio molitor*) and lesser (*Alphitobius diaperinus*) mealworms in rats and processing effect on the lesser mealworm

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PDCAAS AND DIAAS OF MEALWORM



- > DIAAS is part of PhD project by Navodita Malla
- > Status: ongoing

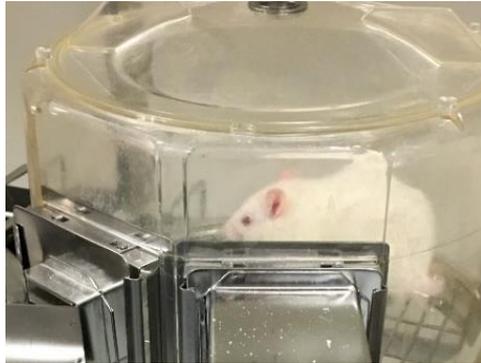




PDCAAS AND DIAAS OF MEALWORM



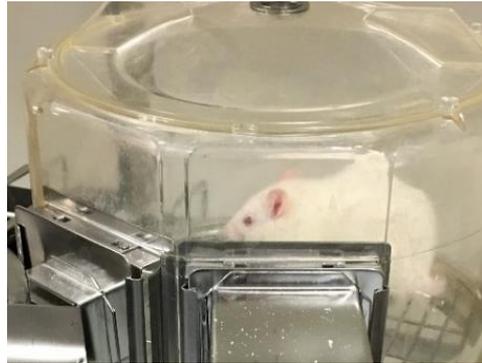
- > Content:
- > Evaluation of protein quality in rats (PDCAAS)
- > Evaluation of protein quality in pigs (DIAAS)





PDCAAS AND DIAAS OF MEALWORM

- > FAO/WHO 1993: Protein digestibility-corrected amino acid score (PDCAAS) was the preferred method to determine protein quality.





PDCAAS AND DIAAS OF MEALWORM

- > Aim:
- > To test different methods of processing of the lesser mealworm
- > ... and to evaluate the effect on protein quality as feed and food.
- > To evaluate the protein quality of the common mealworm.





PDCAAS AND DIAAS OF MEALWORM

Common mealworm , freeze dry

Lesser mealworm, **freeze dry**

Lesser mealworm, **defatted**

Lesser mealworm, **+enzymes**

Lesser mealworm, **extruded**

Lesser mealworm, **hydrolysed (pH 3.7)**

Lesser mealworm, **industrial dried (120-160C)**

Lesser mealworm, **vacuum dried**





PDCAAS AND DIAAS OF MEALWORM

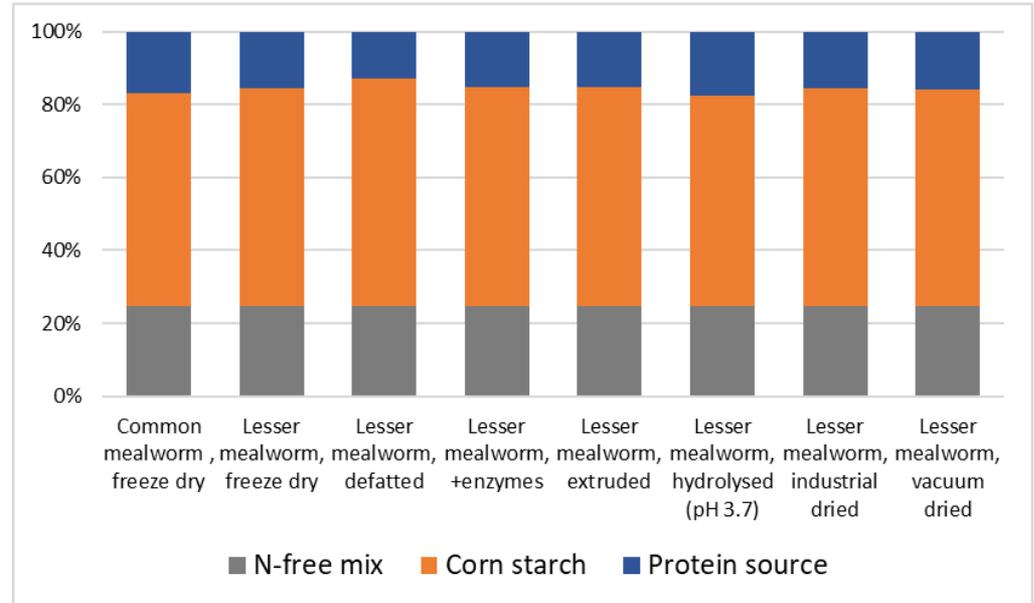
- > 48 rats (66 ± 3 g)
- > Light:dark, 12:12 h
- > $25 \pm 0,5$ °C
- > $43,0 \pm 4,5$ %RH





PDCAAS AND DIAAS OF MEALWORM

- > N-free mix (sugar, oil, minerals, cellulose...)
- > Product up to 10 % crude protein
- > Corn starch fill to 100%





PDCAAS AND DIAAS OF MEALWORM

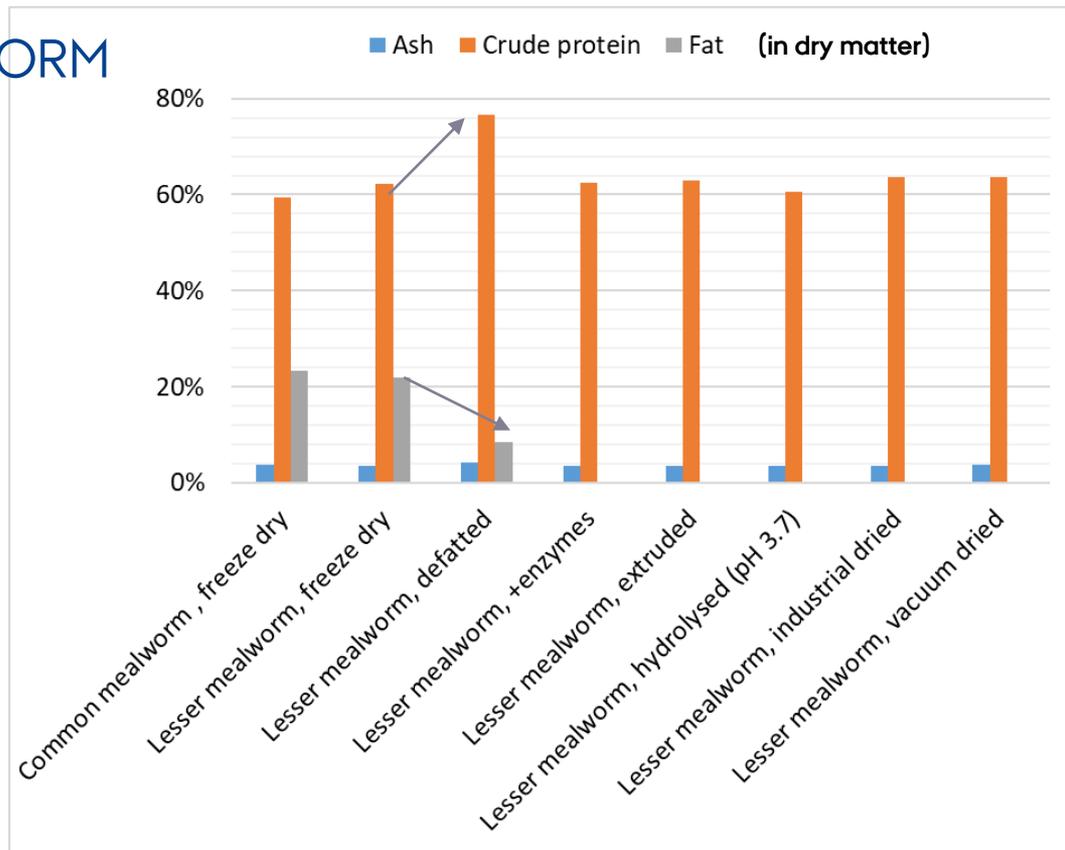
- > 8 groups of 6 rats (n = 6)
- > 2 periods of 24 rats
 - > 5 days of adaptation
 - > 4 days of urine and feces collection





PDCAAS AND DIAAS OF MEALWORM

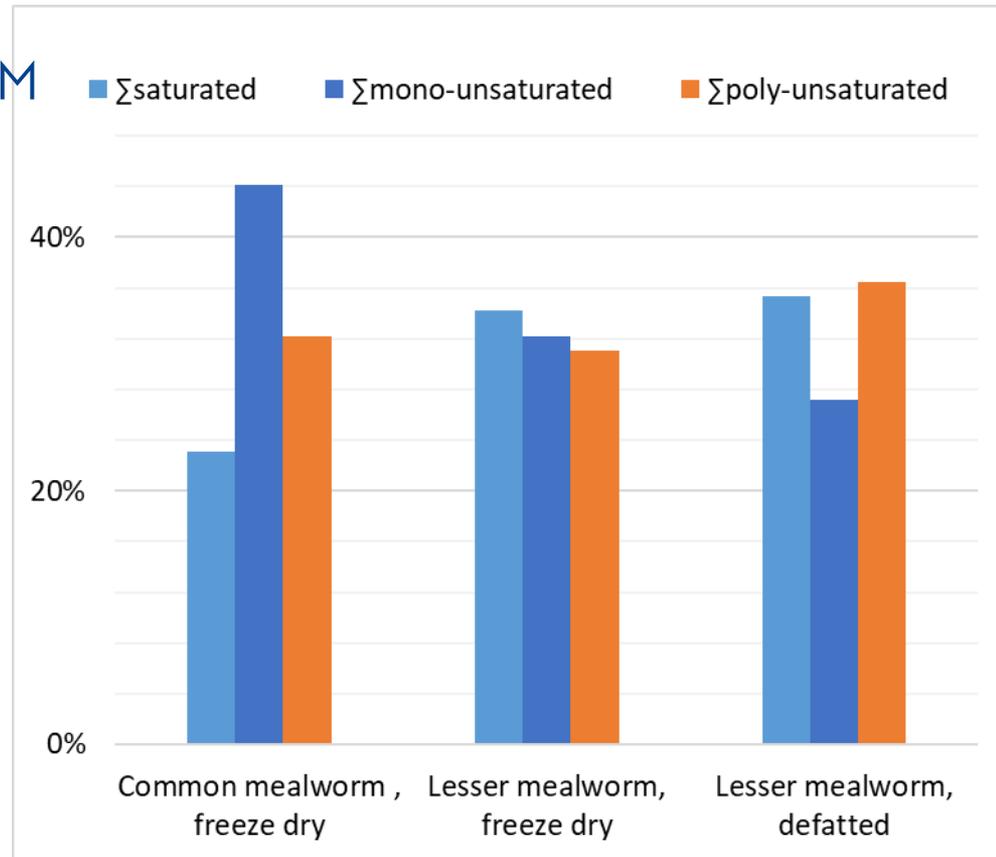
- > Crude protein in dry matter
- > Common mealworm 59%
- > Lesser mealworm (freeze dry) 62%





PDCAAS AND DIAAS OF MEALWORM

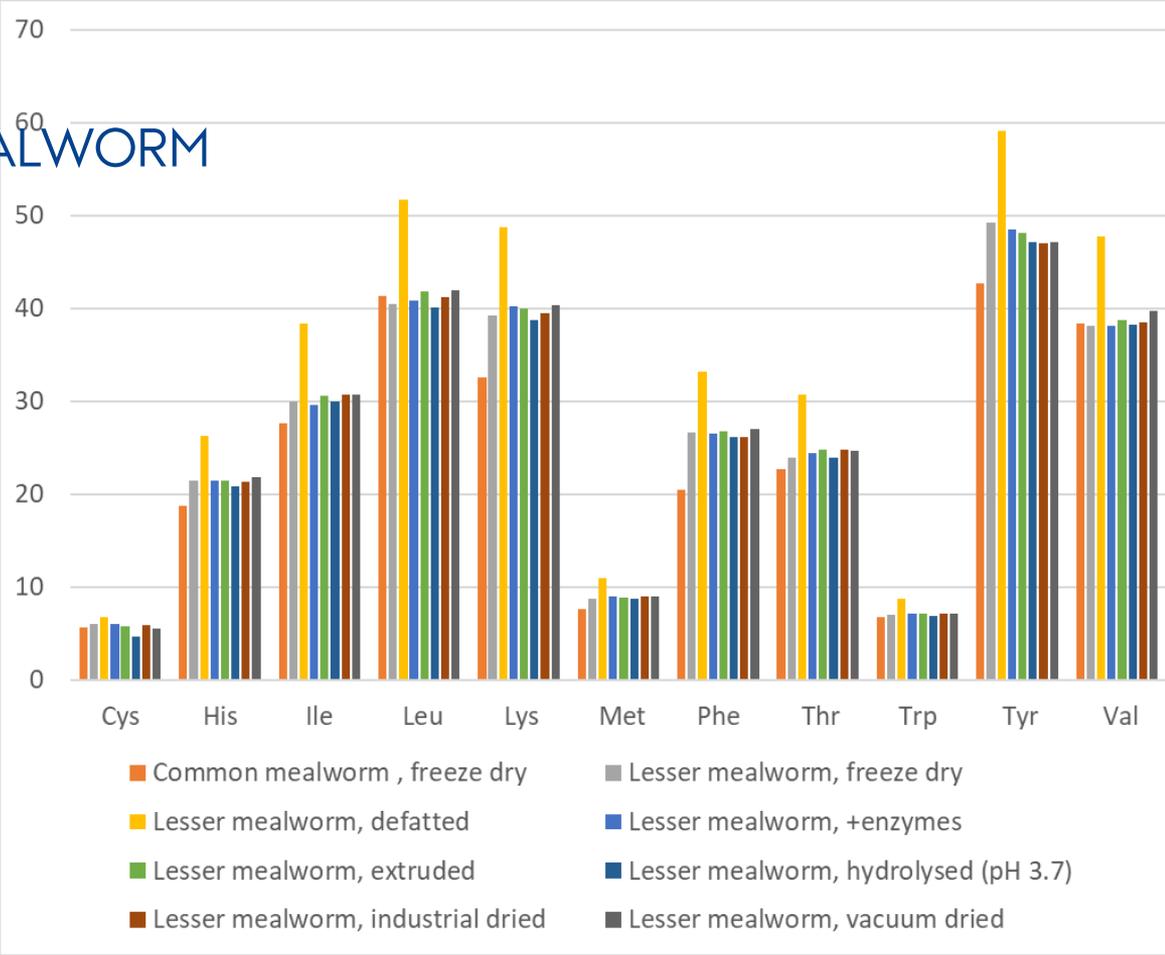
- > Fat in dry matter
- > Common mealworm 25%
- > Lesser mealworm (freeze dry) 22%
- > Lesser mealworm (defatted) 9%





PDCAAS AND DIAAS OF MEALWORM

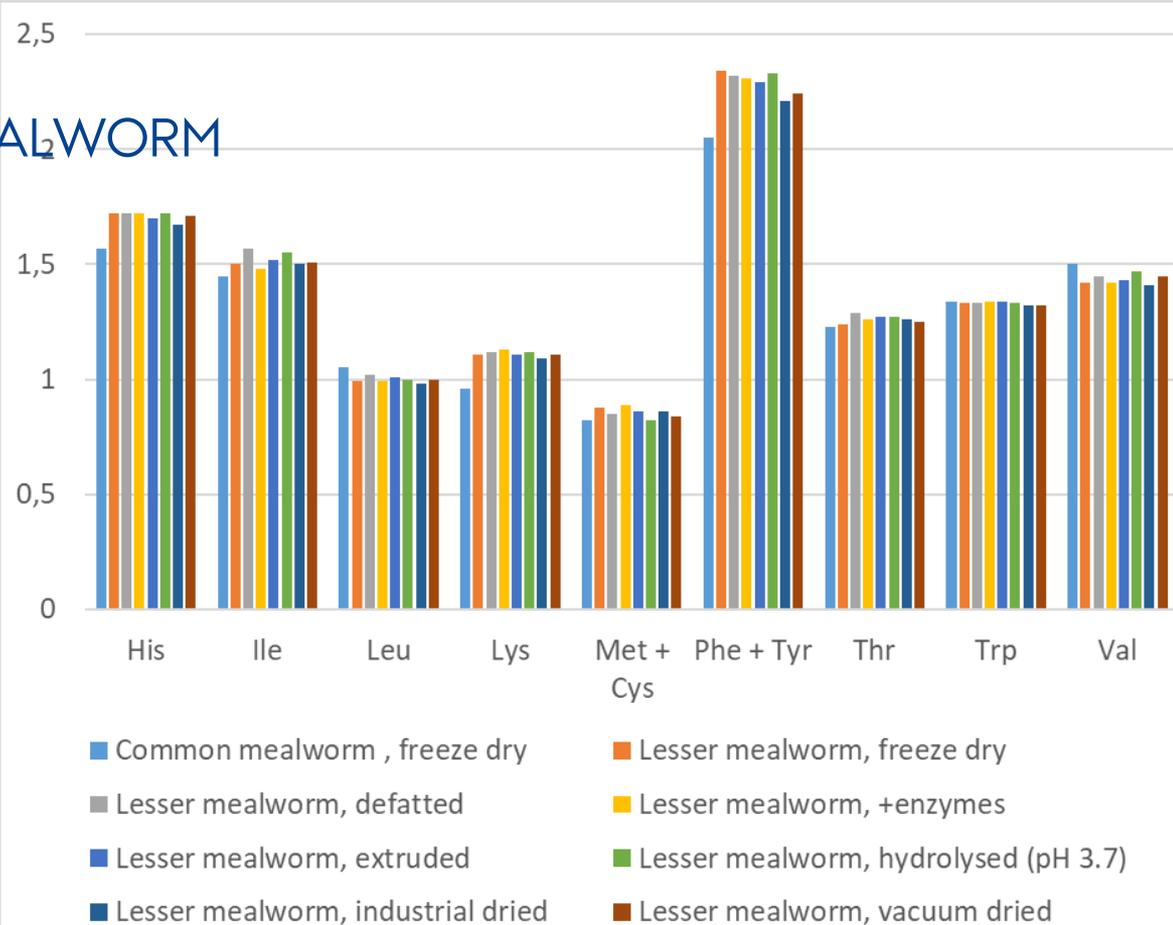
- > Amino acids (g/kg dry matter)
- > Low in sulphur-AA
- > $\Sigma 18$ Amino acid : crude protein
- > Common mealworm, 92%
- > Lesser mealworm, 93-96%





PDCAAS AND DIAAS OF MEALWORM

- > Amino acid score
- > Amino acids compared to human requirement

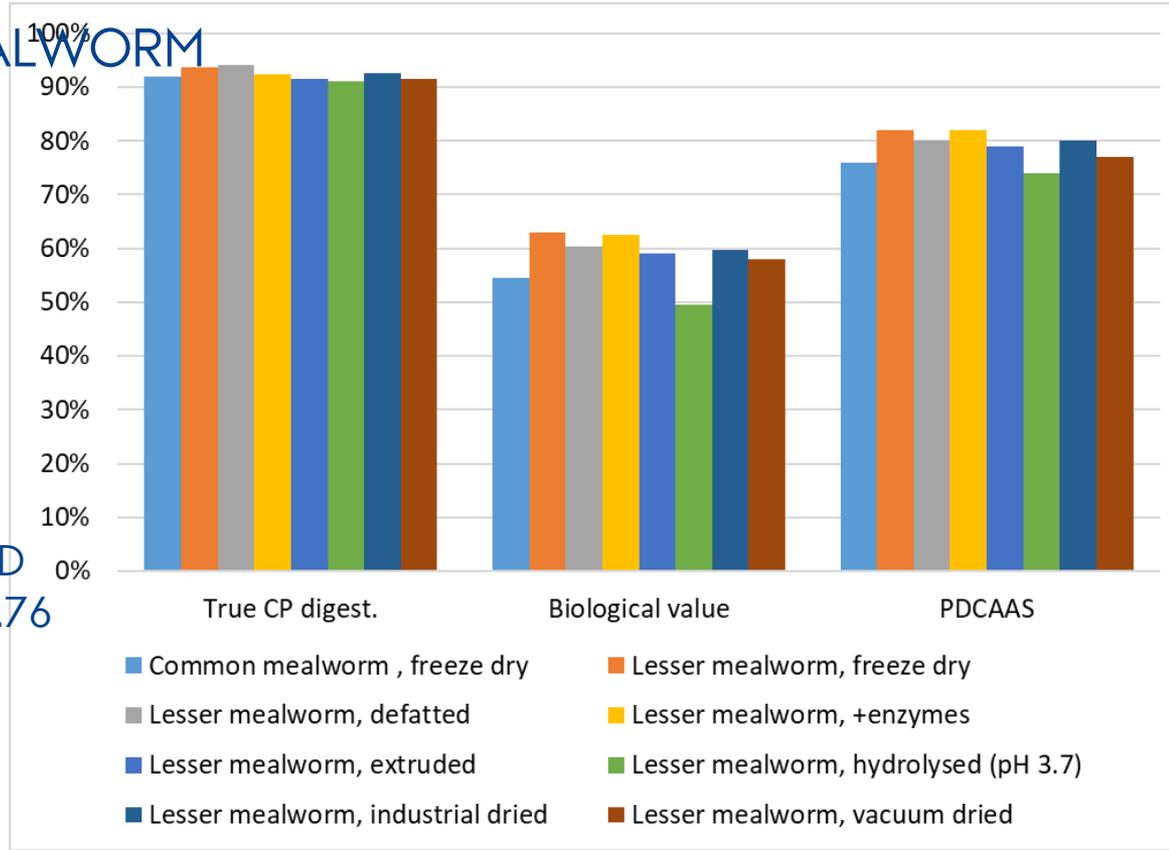




PDCAAS AND DIAAS OF MEALWORM

- > The biological value (BV)
- > $N_{\text{retained}} / N_{\text{absorbed}}$
- >
- > True CP digestibility (TPD)
- > Corrected for endogenous N

- > PDCAAS
- > $AA_{\text{protein}} / AA_{\text{reference}} \times \text{TPD}$
- > Common mealworm PDCAAS 0.76
- > Lesser mealworm PDCAAS 0.79
- > Vary from 0.74 to 0.82





PDCAAS AND DIAAS OF MEALWORM

- > Conclusions:
 - > Nutritional quality was better for lesser compared to common mealworm
 - > PDCAAS
 - > Common mealworm PDCAAS 0.76
 - > Lesser mealworm PDCAAS 0.79
 - > Common industrial procedures (defatting, 120-160 C drying, extrusion) do not have a major impact on protein quality.





PDCAAS AND DIAAS OF MEALWORM

- > FAO 2013: Proposed changing from PDCAAS to Digestible Indispensable Amino Acid Score (DIAAS)



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PDCAAS AND DIAAS OF MEALWORM

> 5 insects and 6 diets

Diet A = N-free diet	
Diet B = <i>Alphitobius diaperinus</i>	Lesser mealworm/ Buffalo larvae
Diet C = <i>Tenebrio molitor</i>	Common/ Yellow mealworm
Diet D = <i>Hermetia Illucens</i>	Black soldier fly larvae
Diet E = <i>Grylodes sigillatus</i>	Banded cricket
Diet F = <i>Acheta domesticus</i>	House cricket

> 6 pigs fed each of 6 diets during 6 weeks
in a Latin square design

		Pig					
		Pig_1	Pig_2	Pig_3	Pig_4	Pig_5	Pig_6
Week	1	Diet 4	Diet 1	Diet 3	Diet 6	Diet 3	Diet 5
	2	Diet 3	Diet 5	Diet 6	Diet 2	Diet 4	Diet 1
	3	Diet 6	Diet 4	Diet 1	Diet 5	Diet 2	Diet 3
	4	Diet 5	Diet 6	Diet 4	Diet 3	Diet 1	Diet 2
	5	Diet 2	Diet 3	Diet 5	Diet 1	Diet 6	Diet 4
	6	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6



PDCAAS AND DIAAS OF MEALWORM

> Diets composed according to FAO recommendations (e.g. 10% crude protein in dry matter)

%	Diet A	Diet B	Diet C	Diet D	Diet E	Diet F
Lesser mealworm		14,276				
Common mealworm			17,312			
Black soldier fly larvae				22,983		
Banded cricket					17,427	
House cricket						14,482
Mineral + Vitamin premix	0,200	0,200	0,200	0,200	0,200	0,200
Titaniumoxid	0,275	0,278	0,277	0,274	0,277	0,278
Sugar	9,163	9,257	9,228	9,127	9,225	9,264
Corn oil	4,581	4,629	4,614	4,563	4,612	4,632
Cellulose fibre	2,749	2,777	2,768	2,738	2,767	2,779
CaCO ₃	1,737	1,737	1,737	1,737	1,737	1,737
Monocalciumphosphate	2,467	2,467	2,467	2,467	2,467	2,467
NaCl	0,263	0,263	0,263	0,263	0,263	0,263
Microgrits/colour	0,500	0,500	0,500	0,500	0,500	0,500
Corn starch	78,065	62,029	57,579	55,148	60,524	63,398



PDCAAS AND DIAAS OF MEALWORM

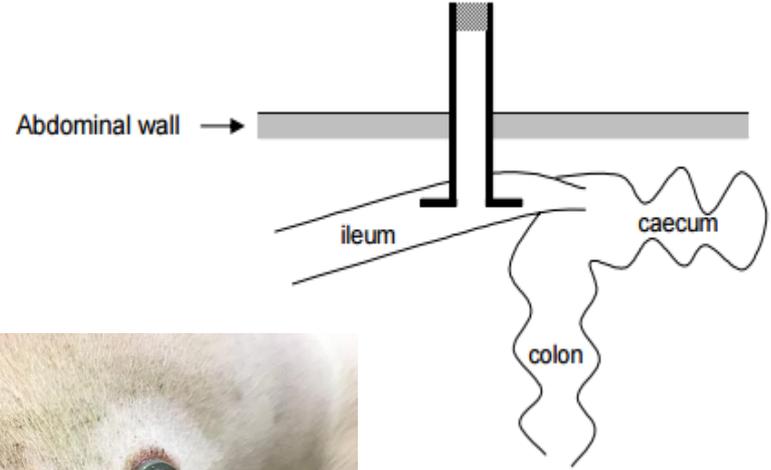
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Common mealworm			17,312			
Mineral + Vitamin premix	0,200	0,200	0,200			
Titaniumoxid	0,275	0,278	0,277			
Sugar	9,163	9,257	9,228			
Corn oil	4,581	4,629	4,614			
Cellulose fibre	2,749	2,777	2,768			
CaCO ₃	1,737	1,737	1,737			
Monocalciumphosphate	2,467	2,467	2,467			
NaCl	0,263	0,263	0,263			
Microgrits/colour	0,500	0,500	0,500			
Corn starch	78,065	62,029	57,579			



PDCAAS AND DIAAS OF MEALWORM

- > 6 pigs fitted with T-canula to collect ileal digesta





PDCAAS AND DIAAS OF MEALWORM

- › Pigs were fed twice daily at 07.30 and 15.30 h
- › Ileal samples collected for 8 hour on d 5 and 7. Pooled.
- › Feed and ileal digesta analyzed for dry matter, ash, crude protein and amino acids.





PDCAAS AND DIAAS OF MEALWORM

> Chemical analysis

% in dry matter	Lesser mealworm	Common mealworm
Crude protein	62	50
Ash	18	13
Fat	27	31

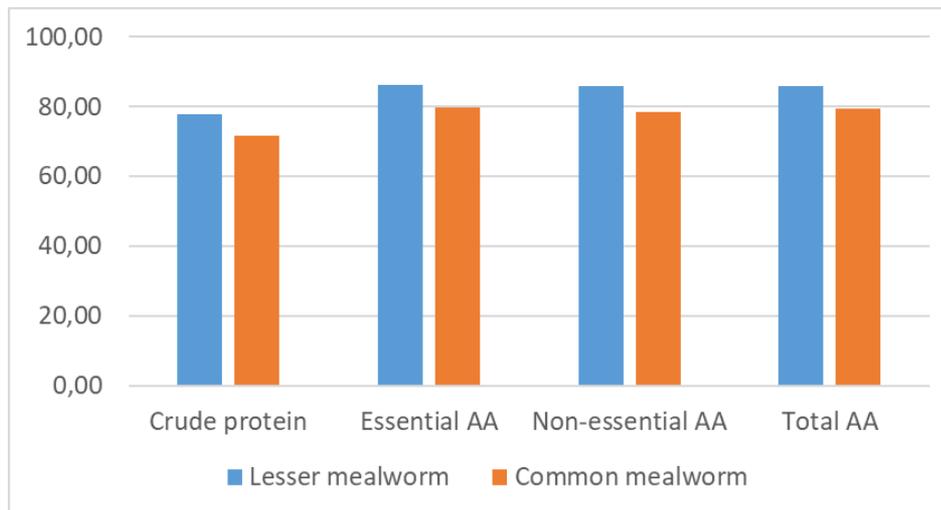
- > From our PDCAAS exp:
- > Lesser mealworm 62% crude protein
- > Common mealworm 59% crude protein





PDCAAS AND DIAAS OF MEALWORM

- > Standardized ileal digestibility
- > Lesser mealworm: 77.8%
- > Common mealworm: 71,7%



- > From our PDCAAS exp:
- > Lesser mealworm 94%
- > Common mealworm 92%





PDCAAS AND DIAAS OF MEALWORM

› DIAAS = mg digestible amino acid per g protein / reference protein

	His	Ile	Leu	Lys	Met+Cys	Phe+Tyr	Trp	Thr	Val	DIAAS %
Infants (birth - 6 months)										
Lesser mealworm	1,33	0,76	0,61	0,78	0,58	1,11	0,22	1,96	0,95	22
Common mealworm	1,07	0,75	0,64	0,57	0,45	0,91	0,20	1,76	0,97	20
Child (6 months-3 yrs)										
Lesser mealworm	1,40	1,30	0,89	0,94	0,71	2,00	0,31	3,91	1,21	31
Common mealworm	1,12	1,29	0,93	0,69	0,54	1,65	0,28	3,51	1,24	28
Older child, adolescent and adult										
Lesser mealworm	1,75	1,39	0,97	1,12	0,83	2,54	0,39	5,04	1,30	39
Common mealworm	1,40	1,38	1,00	0,82	0,64	2,10	0,35	4,52	1,33	35



PDCAAS AND DIAAS OF MEALWORM

- › Conclusions:
- › Digestibility was lower in pigs compared to rats (ileal vs fecal!)
- › DIAAS as measure of protein quality: 0.20-0.39
 - › Lesser mealworm 0.22
 - › Common mealworm 0.20
 - › Low due to low tryptophan.



THANK YOU FOR YOUR ATTENTION

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