Nitrogen balance and ammonia emission from slurries of heavy pigs fed diets with high fibre contents

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INTRODUCTION

In 2005: 12.3 million pigs in Italy: ~50% in Lombardy, the Italian region with more people (~9 millions)

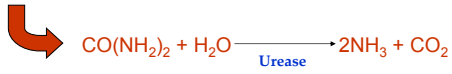
- High pig intensivation
- High emission of harmful gases, NH_3 first
- Research and laws focused on environmental safeguard

Problems linked to ammonia emissions

- ANIMALS:
  - Decrease of animal performance (lower DWG and worse FCR)
  - Delayed puberty in gilts
  - Acute inflammations in the respiratory apparatus
  - Cannibalism
- HUMANS:
  - Chronic bronchitis
  - Asthma
  - Respiratory tract diseases
  - Nasal and ocular inflammations

Pig excreta composition

- Most of faecal N is organic (undigested proteins)
- 70-90% of urinary N is represented by urea
- Ammonia comes from enzymatic hydrolysis of urea



Factors influencing ammonia emissions

- Housing and farming systems
- Nutrition/feeding:
  - Low protein content
  - Acidifying salts
  - Fibrous feeds

Dietetic fibre

- "Non-starch polysaccharides + lignin"
- "The dietetic components resistant to degradation by endogenous enzymes in mammals"

(Theander et al. 1994)

It divides in:

- Soluble fibre
- Insoluble fibre

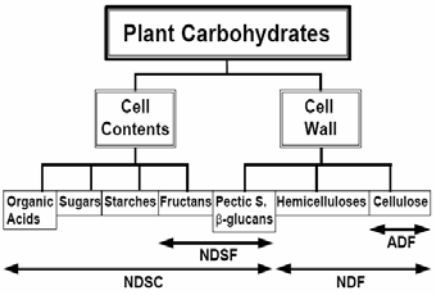
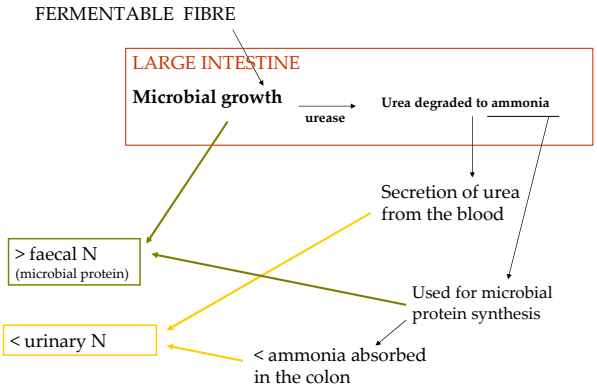


Figure 1. Carbohydrate composition of chemically analyzed fractions. (Pectic S. = pectic substances; ADF = acid detergent fiber; NDF = neutral detergent fiber; NDSC = neutral detergent-soluble carbohydrates; NDSF = neutral detergent-soluble fiber).

Mary Beth Hall. 2000

Fibre characteristics

- Insoluble fibre:
  - Enhances gut peristalsis (> transit speed)
  - Riduces stereotypic behaviours
  - Decreases OM, energy, lipid and protein digestibility
- Soluble fibre:
  - Is well digested
  - Does not enhance gut peristalsis
  - Increases methane and VFA production (energetic sources)
  - Increases the yield of microbial mass (> faecal N and <urinary N)



AIM OF THE EXPERIMENT

- To evaluate the effect of two different kinds of non-starch polysaccharides (NSP) on digestibility, N balance and NH_3 emissions in the heavy fattening pig

MATERIALS & METHODS

- 30 Landrace x Large White castrated male pigs (153 kg BW)
- 5 diets
- 5 digestibility periods
- Metabolic cages

Diet composition

	C	WB12	WB24	BP12	BP24
Maize	51.5	51.5	51.5	51.5	51.5
Barley	36.0	24.0	12.0	24.0	12.0
Wheat bran (WB)	-	12.0	24.0	-	-
Dried beet pulp (BP)	-	-	-	12.0	24.0
Soya bean meal	8.0	8.0	8.0	8.0	8.0
Molasses (cane)	2.0	2.0	2.0	2.0	2.0
Limestone	1.10	1.40	1.40	1.00	0.90
Di-calcium phosphate	0.80	0.50	0.50	0.90	1.00
Salt	0.25	0.25	0.25	0.25	0.25
L-Lysine HCl	0.20	0.20	0.20	0.20	0.20
Vit./min. supplement	0.15	0.15	0.15	0.15	0.15

Diet analysis (on DM basis)

	C	WB12	WB24	BP12	BP24
Ash (%)	4.6	5.5	5.4	4.9	5.3
CP (%)	13.5	14.0	14.6	12.7	12.8
EE (%)	3.5	3.6	3.6	3.9	6.2
NSP (%)	20.5	22.3	24.9	25.1	27.4
NDF (%)	11.8	14.4	17.2	13.3	16.1
ADF (%)	4.8	5.0	6.4	6.8	8.5
ADL (%)	0.8	1.1	1.6	1.0	1.5
Starch (%)	54.4	50.9	47.4	49.0	43.0
Sugars (%)	3.5	3.7	4.0	4.4	5.3
GE (MJ/kg)	18.27	18.29	18.24	18.18	18.16

Digestibility

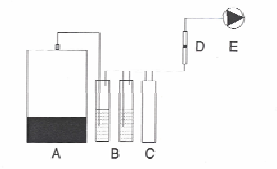
- 6 pigs/dietary treatment
- 6 pigs in individual metabolic cage: 2 per dietary treatment
- Each digestibility period: 2 weeks
  - 1 week: adaptation
  - 1 week: collection

Sampling of excreta

- Daily sampling at 8.00
- Faeces: 20% of total weight and freezed (-20°C)
- Urine: 10% of total weight and freezed
- Urine previously added with 150 ml solution at 20% H_2SO_4 (v/v) to avoid ammonia losses

Ammonia trapping

(Dierikx & Aarnink, 1993)



A= vessel with slurry; B= impingers; C= water trap;
D= flow control; E= pump

- 2 kg of excreta proportional to the amounts of faeces and urine produced
- Urine not previously added with H_2SO_4
- Impingers containing HNO_3 (0.5 M)
- Flow rate: 4.2 L/min
- 14 days of monitoring

Statistical analysis

GLM procedure of SAS statistical package

Model: $Yi = \mu + \alpha i + \varepsilon ij$

Yi = experimental datum;
μ = general mean;
αi (i=1…..5) = dietary treatment effect;
εij = error.

("Period" effect was not included in the model, since not significant in a preliminary analysis)

RESULTS

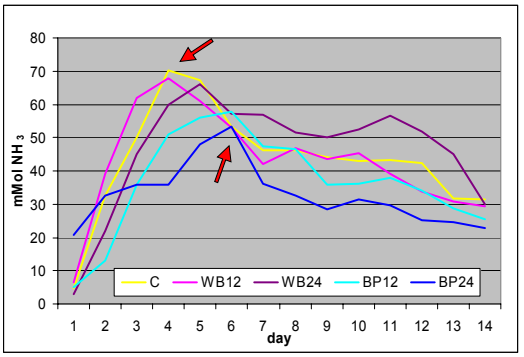
• Digestibility

	C	WB12	WB24	BP12	BP24	SE
DM	90.1^{a}	86.0^{c}	83.5^{d}	88.1^{b}	86.0^{c}	0.61
Ash	55.6^{ab}	50.5	44.0^{c}	53.0^{b}	47.5^{bc}	2.31
OM	91.8^{a}	88.1^{c}	85.7^{d}	89.9^{b}	88.1^{c}	0.53
CP	90.3^{a}	86.8^{b}	84.1^{c}	84.6^{c}	80.1^{d}	0.71
EE	81.1^{a}	74.7^{b}	69.9^{c}	75.8^{b}	81.3^{a}	1.37
NDF	60.9^{a}	51.3^{b}	49.0^{b}	64.9^{a}	67.8^{a}	2.45
ADF	54.2^{b}	41.5^{c}	43.3^{c}	64.7^{a}	67.5^{a}	2.46
Energy	90.6^{a}	86.6^{c}	84.0^{d}	88.4^{b}	86.3^{c}	0.58

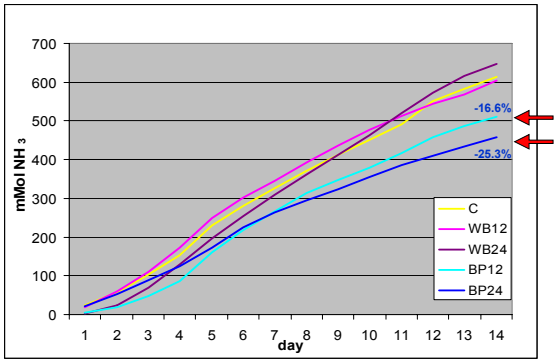
• N balance

		C	WB12	WB24	BP12	BP24	SE
Intake (IN)	g/d	57.9^{b}	61.0^{a}	62.3^{a}	52.9^{c}	53.7^{c}	0.99
	g/kg MW	1.30^{b}	1.38^{a}	1.44^{a}	1.27^{bc}	1.23^{c}	0.03
Faecal	g/d	5.8^{c}	7.5^{b}	10.1^{a}	8.6^{b}	10.4^{a}	0.41
	% IN	**10.0^{d}**	**12.3^{c}**	**16.3^{b}**	**16.3^{b}**	**19.3^{a}**	0.75
	g/kg MW	0.13^{d}	0.17^{c}	0.23^{a}	0.21^{b}	0.23^{a}	0.01
Urinary	g/d	26.8^{a}	25.2^{ab}	27.5^{a}	20.4^{b}	22.5^{ab}	1.89
	% IN	**46.2**	**41.3**	**44.2**	**38.7**	**41.9**	3.26
	g/kg MW	0.60^{ab}	0.57^{ab}	0.64^{a}	0.49^{b}	0.51^{b}	0.05
Excreted	g/d	32.6^{ab}	32.8^{ab}	37.7^{a}	29.0^{b}	32.9^{ab}	1.77
	% IN	**56.2**	**53.6**	**60.6**	**55.0**	**61.3**	3.11
	g/kg MW	0.73^{b}	0.74^{ab}	0.87^{a}	0.70^{b}	0.75^{ab}	0.04

Daily ammonia emission



Cumulative ammonia emission



CONCLUSIONS

Possibility to foresee beet pulp-based diets for the heavy fattening pig

- Higher fibre digestibility for beet pulp than for wheat bran
- Decrease of urinary N at increasing NSP

Beet pulp permitted a consistent decrease of ammonia emission from slurries