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Méthodes de prévision des valeurs nutritives des aliments pour le porc: contexte international

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Introduction

- Cost of feed: > 60% of cost of pig meat production
- More ingredients are available + competition between animal species, with biofuels, with humans, etc.
- Improvement in knowledge/methods about pig requirements + new constraints in pig production (environment, etc.)
- Evaluation of feeds is becoming more and more critical; coherence with expression of animals requirements
- International exchanges of ingredients and technologies (formulation, etc.) : common methods???
- Nutritional concepts: energy, protein, minerals, vitamins, ...

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Energy

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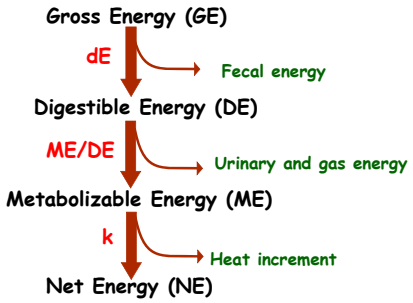
Energy utilization



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Digestibility of nutrients in (growing) pigs

Nutrient	% fecal	Site of digestion
Starch & sugars	#100	Small intestine
Proteins	>90	Small intestine
Fat	70-90	Small intestine
NSP-Dietary fiber-….	0-100	Hindgut

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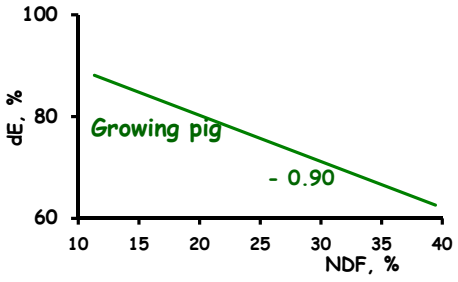
Digestibility of energy in growing pigs (n=77)



Le Goff and Noblet, 2001

BW and energy digestibility in growing pigs

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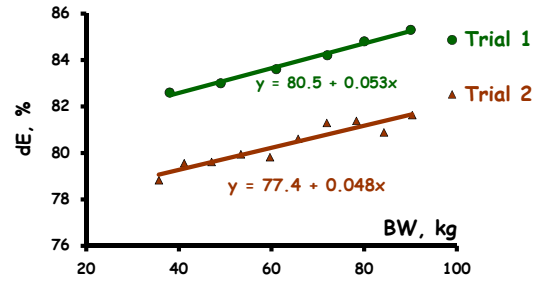

Trial 1: 4 diets and 5 pigs/diet
Trial 2: 1 diet and 20 pigs

INRA data

Digestibility of energy in growing and adult pigs (n=77)

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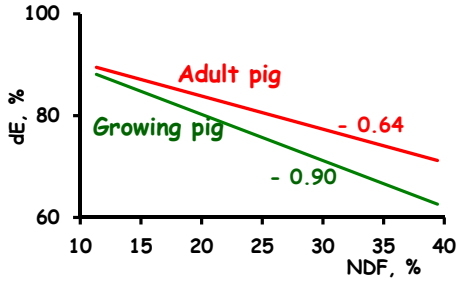

Le Goff and Noblet, 2001

Digestibility of energy in growing and adult pigs

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	Growing	Adult	Δ,%dEg
Wheat	87.6	89.2	+1.8
Corn	87.9	91.4	+4.0
Soybean meal	85.2	90.4	+6.2
Wheat bran	56.7	62.7	+10.4
Corn gluten feed	65.6	76.4	+16.5
Soybean hulls	51.4	70.3	+36.8

INRA & AFZ feeding tables

Effect of technology on dE of pig feeds

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Technology	Mash		Pellet
Wheat-SBM diets (n=2)	88.6	*	89.2
Corn-SBM diets (n=3)	88.4	**	90.3
Corn (n=5)	87	**	90
Full-fat rapeseed	35	**	83
Linseed (extrusion)	51	**	84

INRA data

Urinary and gas energy

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- In the growing pig:
  - E urines, MJ/kg DM=0.19+0.031xN urines (g/kg DM)
    (N urines = 50% digestible N)
  - E methane: related to fermented energy (<0,5% of DE)
  - ME/DE is about constant in complete and balanced feeds (#96%) and varies between 91% (Soybean meal) and 100% (fat) for ingredients

DM: feed dry matter intake

Le Goff and Noblet, 2001; Noblet et al., 2004

Efficiencies of utilization of ME of nutrients (k_g, %)

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Crude protein	58
Crude fat	90
Starch	82
Dietary fiber	58

↳ **Prediction equations of NE**

Noblet et al., 1993; 1994

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Comparison of energy systems (pig)*

	DE		ME		NE	NE/ME
Ingredients						
Fat	243	+	252	++	300	90
Corn	103	=	105	+	112	80
Pea	101	=	100	-	98	73
Wheat bran	68	=	67	-	63	71
Soybean meal	107	-	102	--	82	60

** As % of the energy value of a compound feed (wheat: 67%, soybean meal: 16%, fat: 2.5%, wheat bran: 5%, peas: 5%, ...)*

INRA&AFZ feeding tables

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Conclusion (1)

Energy value of pig feeds depends on:

- evaluation system: DE vs ME vs NE; + which NE equation?
- pig BW; + how many stages?
- technology (pelleting, enzymes, etc.)
- composition of "reference ingredient"
- Etc.

- Many potential energy values for a given ingredient/feed
- Methods of prevision should consider this "complexity"!!!
- Methods based on in vivo, in vitro and chemical analyses

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Protein

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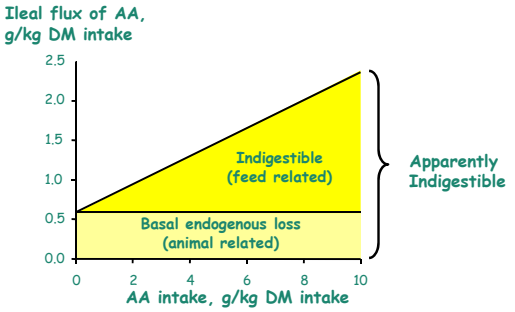
Partition of ileal amino acid flux in the growing pig



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Standardised digestible amino acids (SID AA)

- SID values: independent from the feed CP content
- SID amino acid contents of ingredients are additive
- SID values are supposed
  - to be identical at all stages of pig production
  - to be little effected by technology (???; lack of infos)
- Internationally accepted concept (Stein et al., 2007); => most data bases with this concept => they are comparable (at least relative values)

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Lysine content of ingredients

	Total	SID
Diet	100	100
Ingredients		
Maize	29	26
Wheat	36	33
Wheat bran	68	53
Soybean meal	340	353
AA mixture**	4580	5180

** As % of the lysine content of a diet containing wheat (67%), soybean meal (16%), fat (2.5%), wheat bran (5%), peas (5%), HCl-lysine (0.10%), methionine (0.05%), threonine (0.05%), ..*

*** 50% HCl-lysine, 25% threonine, 25% methionine*

INRA&AFZ feeding tables

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Feeding tables

EvaPig

In vitro methods

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Feeding tables for pig feeds

Plus "hundreds" of non academic/"home made"/etc. tables

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Comparison of tables and concepts for pig feeds evaluation

- Energy
  - NE (in fact NEs) is becoming more and more used: Europe (except Germany), North America (NRC in 2012 as "effective ME") , Brazil, China, etc.
  - Differentiation between pig stages: mostly Europe
  - Effect of technologies: marginally applied
  - Problem of controls!!!!
- Protein and amino acids
  - Standardized ileal digestibility (+ ideal protein) : "worldly" accepted. Effects of technologies?
- Phosphorus:
  - Digestible (apparent vs standardized) vs available vs ???
  - Phytase effects???
  - A bit complex and confusing

Coherence nutritional values *vs* animal requirements

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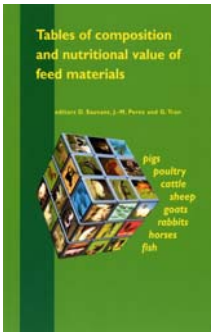
INRA & AFZ feeding tables

Languages: French, English, Spanish, Chinese



More info at:
http://www.zootechnie.fr/tables/index.htm

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80 *Tables of composition and nutritional value of feed materials*

Maize

Pigs	Growing	Sow
DE (MJ/kg)	14.2	14.8
ME (MJ/kg)	13.9	14.4
NE (MJ/kg)	11.1	11.4
Ed (%)	88	91
OMd (%)	91	94
Nd (%)	81	91
NSId (%)	86	
EEd (%)	60	
Pd (%)	28	

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80 *Tables of composition and nutritional value of feed materials*

Maize

Amino acid content and digestibility											
Amino acids	Total		Pigs					Poultry		Ruminants
	g/kg	% CP	AID %	AIDC g/kg	SID %	SIDC g/kg	TD %	TDC g/kg	AADI % PDIE
LYS	2.4	3.0	70	1.7	80	1.9	85	2.1	5.7
THR	3.0	3.7	74	2.2	83	2.5	88	2.7	4.8
MET	1.7	2.1	87	1.5	91	1.5	94	1.6	1.9
CYS	2.0	2.5	82	1.7	89	1.8	93	1.9	
MET+CYS	3.7	4.6	85	3.1	90	3.3	93	3.5	
TRP	0.5	0.6	65	0.3	80	0.4			
ILE	3.0	3.7	82	2.5	88	2.7	92	2.8	4.9
VAL	4.1	5.0	81	3.3	87	3.6	92	3.8	5.5
LEU	10.2	12.5	90	9.2	93	9.5	96	9.8	10.2
PHE	4.0	4.9	87	3.5	91	3.7	94	3.8	5.0
TYR	3.4	4.2	85	2.9	90	3.1	94	3.2	
PHE+TYR	7.4	9.1	86	6.4	91	6.8	94	7.0	
HIS	2.4	2.9	84	2.0	89	2.1	90	2.1	2.3
ARG	3.8	4.7	85	3.2	91	3.5	95	3.6	4.6
ALA	6.1	7.5	84	5.2	89	5.5	94	5.8	
ASP	5.3	6.5	79	4.2	87	4.6	90	4.8	
GLU	15.4	18.9	89	13.7	93	14.3	96	14.8	
GLY	3.1	3.8	69	2.1	82	2.5	89	2.7	
SER	4.1	5.0	83	3.4	89	3.6	93	3.8	
PRO	7.5	9.2	82	6.2	89	6.7	96	7.2	

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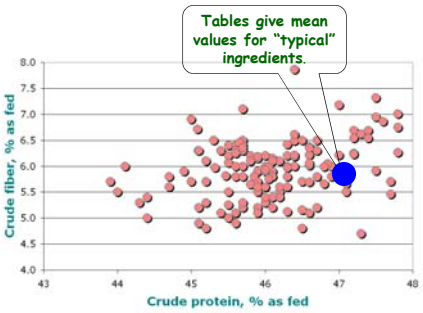
Feeding Tables?



Soybean meal 48

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Estimation of nutritional values of pig feeds

- In vivo measurements: cost, delay, ethics, etc.!!!!!
- Tabular values in feeding tables: = average values!
- Chemical analyses: prediction equations or "marginal" corrections
- In vitro methods: a little for energy; pbs for amino acids
- NIR methods: a little for amino acids

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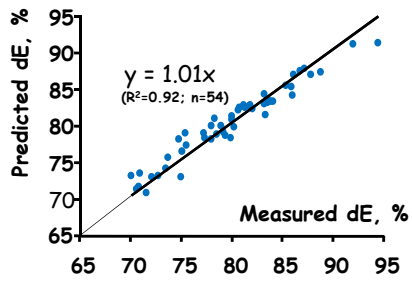
Validation of dOMv equations

(compound feeds; mash)

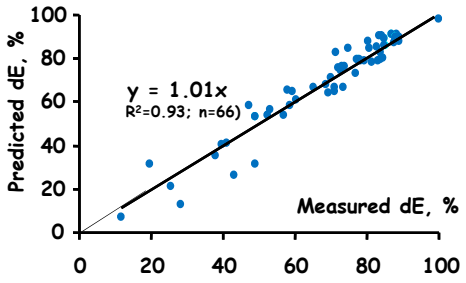


Equation dOMv, Ash & ADF

Noblet and Jaguelin, 2007

Validation of dOMv equations

(ingredients; mash)



Predicted: equation dOMv, Ash & ADF

Noblet and Jaguelin, 2007

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Conclusions

- Different sets of energy values should be used for piglets + G-F pigs and adult sows; NE is preferable
- Adjustment of energy values should be done for technological treatments, enzymes addition, etc. Bases are not fully available: knowledge is required.
- Concepts and prediction methods remain variable between …; moderate development of rapid and accurate (*in vitro*, NIR, etc.) methods in addition to *in vivo* and chemically based techniques => major challenge

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Thanks

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