

# What do we know about feeding Peas, Lentils and Flax?



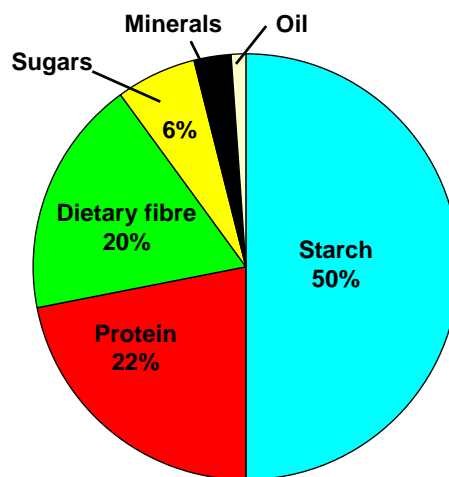
Pascal Leterme, PhD

Prairie Swine Centre Inc.



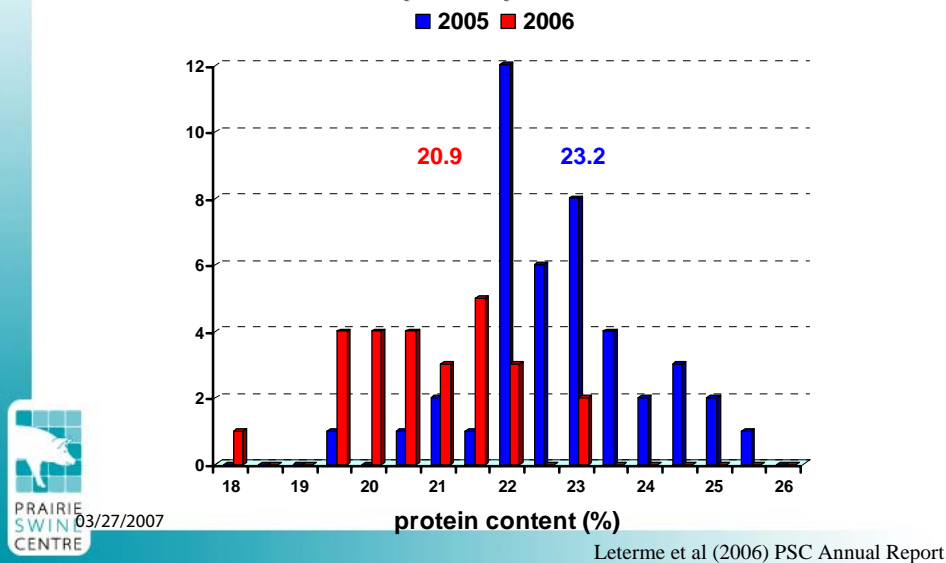
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## Composition of peas



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## Effect of environmental conditions on pea protein content



## Varietal effect on pea protein content

g/ kg DM

**2005**

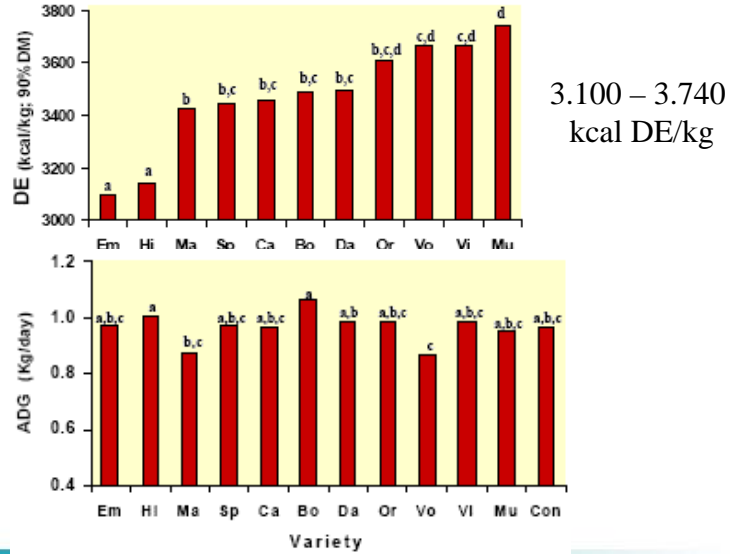
n = 8

**2006**

n = 3

Admiral	220 ± 13	Cooper	197 ± 5
Eclipse	232 ± 12	Midas	202 ± 7
Cutlass	234 ± 12	Cutlass	204 ± 9
Golden	235 ± 8	Nitouche	216 ± 9
Bronco	236 ± 14	Stratus	228 ± 9

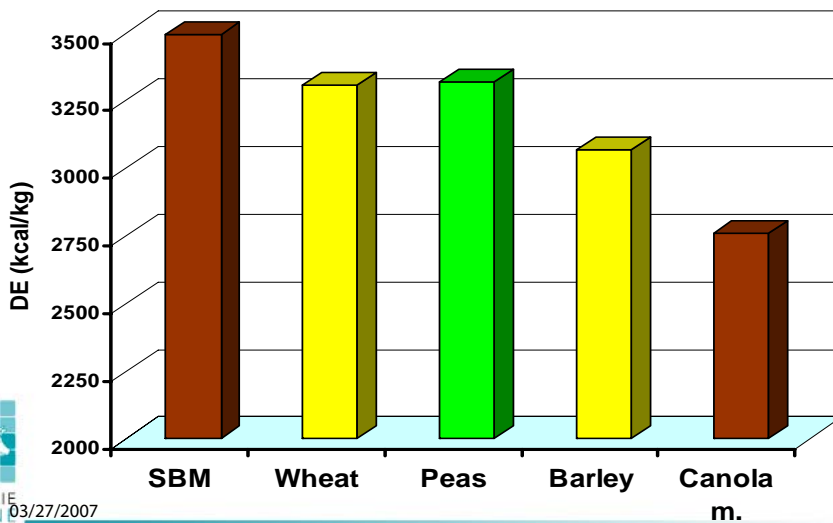
## Variability in DE content and peas and effect on pig growth



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Zijlstra & Patience (1997 PSC Annual Report)

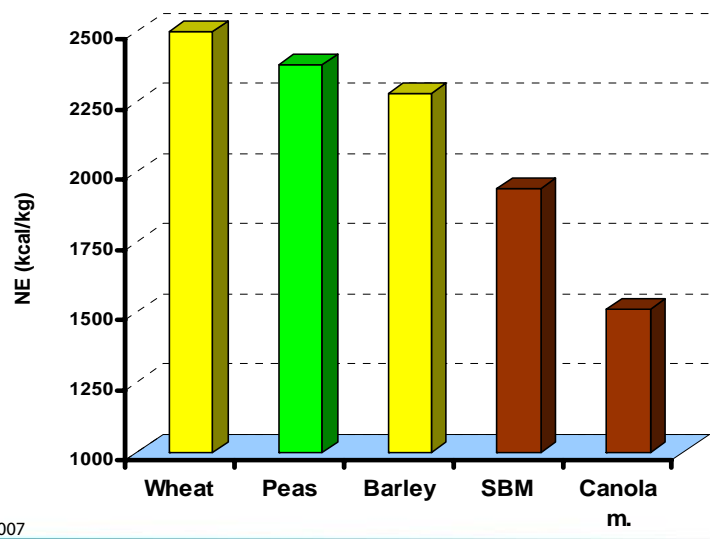
## DE value of peas in pigs as compared to other feed ingredients



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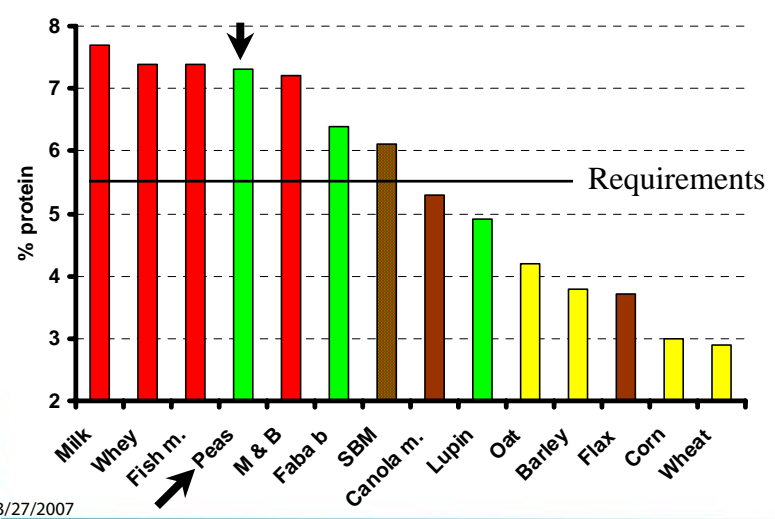
Sauvant et al (2004) INRA Tables, France

## NE value of peas in pigs as compared to other feed ingredients



Sauvant et al (2004) INRA Tables, France

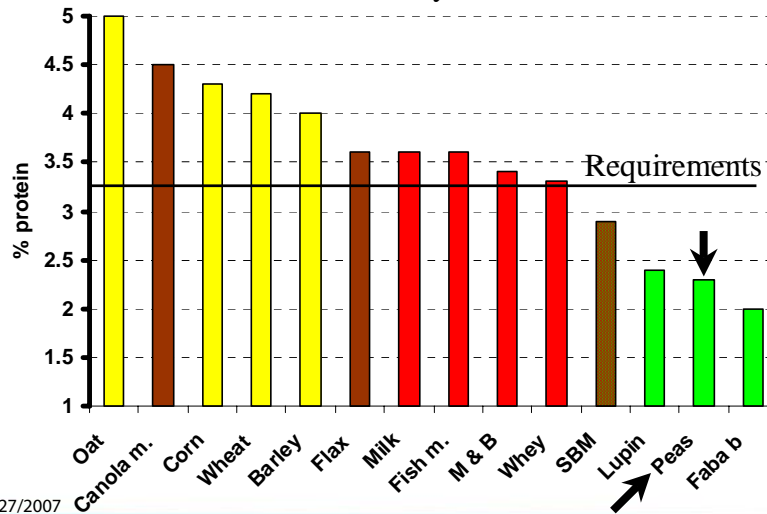
## Lysine content of peas as compared to other feed ingredients



Sauvant et al (2004) INRA Tables, France

## S-containing AA content of peas as compared to other feed ingredients

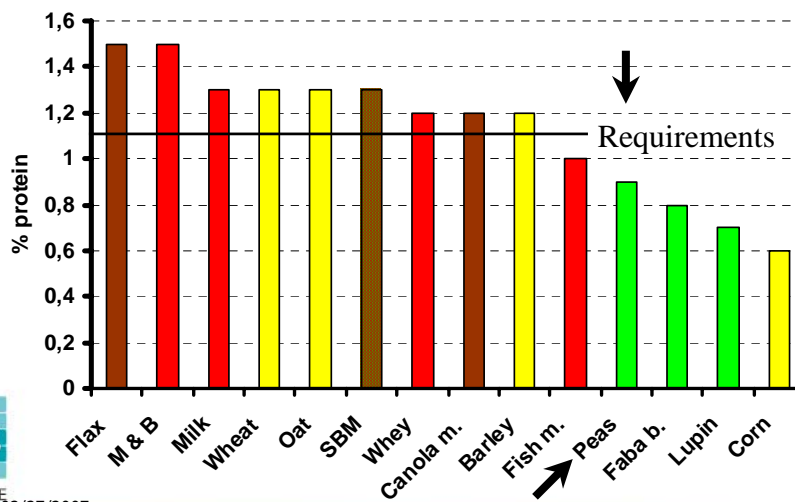
Methionine + cysteine



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Sauvant et al (2004) INRA Tables, France

## Tryptophan content of peas as compared to other feed ingredients



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Sauvant et al (2004) INRA Tables, France

Effect of supplementation of pea-based diets with TRP or MET on growth performance of piglets

	Corn		
	Control	Peas	Peas+T
Corn	67	54	54
Wheat	-	-	-
<b>PEAS</b>	-	<b>24</b>	<b>24</b>
SBM	24	13	13
Fish meal	6	6	6
Trp	-	-	0.03
Met	-	-	-
Weight (kg)	12	12	12
<b>ADG(g)</b>	<b>451<sup>a</sup></b>	<b>352<sup>b</sup></b>	<b>491<sup>a</sup></b>
FCR	2.20	2.33	2.10



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Gatel & Grosjean (1990) Livest. Prod. Sci. 26, 155

Effect of supplementation of pea-based diets with TRP or MET on growth performance of piglets

	Corn			Wheat		
	Control	Peas	Peas+T	Control	Peas	Peas+M
Corn	67	54	54	-	-	-
Wheat	-	-	-	63	49	49
<b>PEAS</b>	-	<b>24</b>	<b>24</b>	-	<b>30</b>	<b>30</b>
SBM	24	13	13	32	16	16
Fish meal	6	6	6	-	-	-
Trp	-	-	0.03	-	-	-
Met	-	-	-	-	-	0.12
Weight (kg)	12	12	12	11	11	11
<b>ADG(g)</b>	<b>451<sup>a</sup></b>	<b>352<sup>b</sup></b>	<b>491<sup>a</sup></b>	<b>561<sup>a</sup></b>	<b>573<sup>a</sup></b>	<b>604<sup>b</sup></b>
FCR	2.20	2.33	2.10	1.80a	1.87b	1.77a



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Gatel & Grosjean (1990) Livest. Prod. Sci. 26, 155

## Effect of pea inclusion on the ADG of growing-finishing pigs

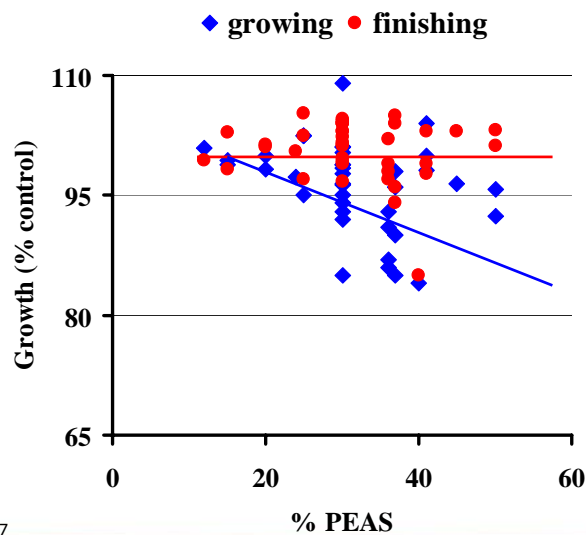
PEAS	0	12	24	36
Corn	73	64	56	47
SBM	23	19	15	11
Trp/Met			*	**
ADG g/d	729	752	748	729



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Stein et al (2004) J. Anim. Sci. 82, 2568

## Response of growing and finishing pigs to pea inclusion in the diet



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Gatel & Grosjean (1990) Livest. Prod. Sci. 26, 155

## 1<sup>st</sup> message

- **Peas have a high NE value**
- **Pea proteins**
  - Have the highest lysine content of any plant ingredient used in swine nutrition
  - Are deficient in S-containing amino acids and in Tryptophan
- **Peas can represent up to**
  - 30% of the diet of growing pigs
  - 40% of the diet of finishing pigs



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## Maple peas

- *Pisum sativum arvense*
- High tannin content (coloured hulls)
- Effect on protein digestibility
  - + tannins : 71-77 %
  - tannins : 78-85 %
- Effect on energy value
  - 400 kcal DE/kg DM
- Effect on pig growth
  - + tannins : 600 g ADG
  - tannins : 640 g ADG



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Gatel (1994) Anim. Feed Sci. Technol 45, 317  
Grosjean et al (1991) JRP 23, 53

## Marrowfat peas

- Harvested in dry form and re-hydrated
  - Canned peas
  - Mashed peas
- In the UK, long growth period
- Large, wrinkled peas
- Varieties: Maro, Progreta
- High trypsin inhibitor content
  - Spring peas 1.9-3.1 U/mg
  - Winter peas 7.5-12 U/mg
  - Marrowfat 8-10 U/mg
- Protein digestibility < 10%
- No effect on DE

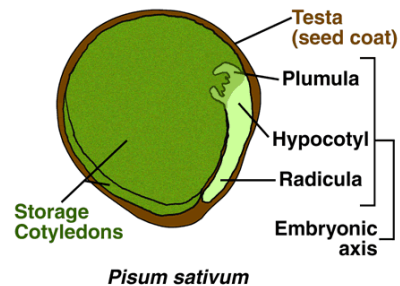


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Leterme et al (1990 & 1992) Anim. Feed Sci. Technol 29, 45 & 37, 309

## Pea hulls

<i>g/kg DM</i>	<b>Peas</b>	<b>Hulls</b>
Cr. protein	232	82
Starch	500	68
Dietary fibre	169	817
NDF	158	637
Ash	30	31
DE (kcal/kg DM)	3900	3325
NE (kcal/kg DM)	2675	2080
Dig. protein	74	42

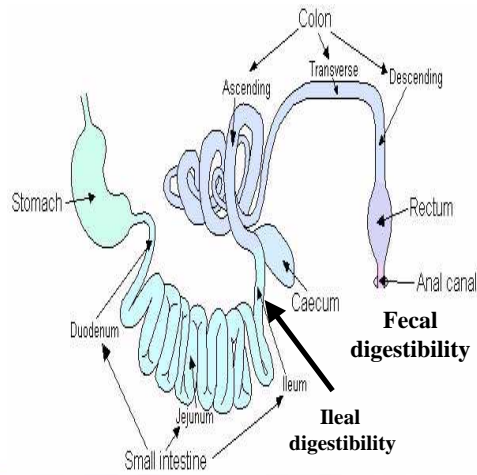


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Noblet et al (2007) JRP 40, 111-118

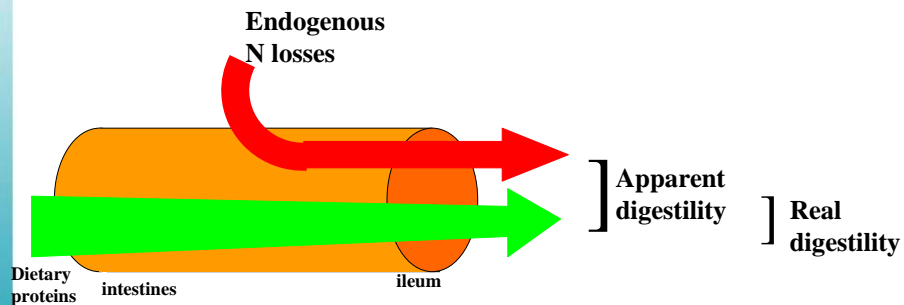
## Ileal and fecal digestibility of peas in pigs

- **Ileal digestibility**
  - Protein: 70%
  - Starch: 95%
  - Dietary fibre: 30%
  - Energy: 70%
- **Fecal digestibility**
  - Protein: 80%
  - Starch: 100%
  - Dietary fibre: 90%
  - Energy: 85%



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## Protein digestibility in pigs



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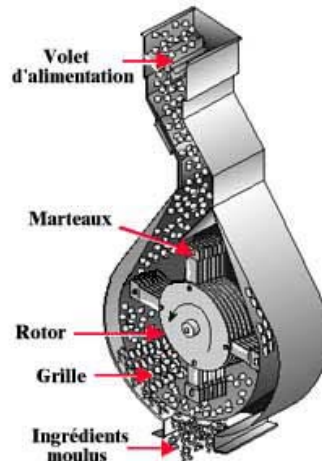
## Grinding

- **Reduction of size of particles**

- Increase accessibility to nutrients



- Increase real protein digestibility
  - Decrease endogenous protein losses
  - Increase AA availability



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## Effect of grinding on pea protein digestibility in pigs (micronization - 60 $\mu\text{m}$ )

	Raw	Micro
<u>App. Digestibility</u>		
N	70	87
Lysine	73	89
<u>Real digestibility</u>		
N	81	90
Lysine	83	95
<u>Endogenous losses (g/kg feed)</u>		
N	2.84	1.78
Lysine	0.57	0.35
<u>Availability</u>		
N	70	92
Lysine	82	89



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Hess et al. (2000) JRP 32,

## Effect of grinding and heating on pea protein digestibility in pigs (200, 500 and 1000 $\mu\text{m}$ , 3 min at 85 °C)

	1000 $\mu\text{m}$		500 $\mu\text{m}$		200 $\mu\text{m}$	
	-	+H	-	+H	-	+H
<u>App. Digestibility</u>						
N	63 <sup>a</sup>	65.5 <sup>a</sup>	68 <sup>b</sup>	74 <sup>c</sup>	76 <sup>c</sup>	78 <sup>d</sup>
Threonine			62 <sup>a</sup>	68 <sup>b</sup>	70 <sup>b</sup>	74 <sup>c</sup>
<u>Real digestibility</u>						
N			78 <sup>a</sup>	83 <sup>b</sup>	86	87
Threonine			77 <sup>a</sup>	84 <sup>b</sup>	87 <sup>c</sup>	88 <sup>c</sup>
<u>Endogenous losses</u>						
N			2.60	2.45	2.47	2.42
Threonine			0.57 <sup>a</sup>	0.45 <sup>b</sup>	0.64 <sup>a</sup>	0.44 <sup>b</sup>



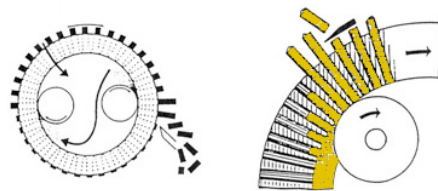
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Lahaye (2004) PhD INRA Rennes, France

## Other treatments

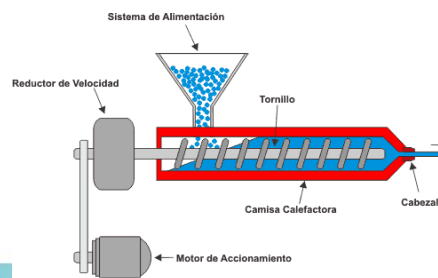
### • Pelleting

- destruction ANF, bacteria and protein structure of the feed
- increase digestibility
- increase feed intake
- **peas provide excellent quality of pellets**



### • Extrusion

- gelatinization of starch and increase of digestibility
- destruction of ANF and bacteria



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## Consequences of the high rate of pea fibre fermentation in pigs

- **Energy supply**
  - Short-chain fatty acids produced in large intestine
- **Constipation in sows**
  - Lack of rest
- **Shift of N**
  - ↗ N faecal excretion, ↘ urinary N excretion
- **Possible “prebiotic” effect**
  - Stimulation of health promoting-bacteria



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## Economic interest of peas

- **Peas = 0.6 x wheat + 0.4 x soybean meal**
  - Peas = \$144/t
  - Wheat = \$142/t
  - SBM = \$ 270/t
  - Price of peas according to their nutritional value: \$193
- **Availability?**
- **Cost of transport?**



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## 2<sup>nd</sup> message

- Sows can be fed with peas as long as other fibre sources are used in the diet
- Grinding markedly improves the nutritional value of peas in pigs
- Other treatments can also improve the nutritional value but at a lower rate



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## Lentils

- *Lens culinaris*
- Human nutrition
- Canada 2<sup>nd</sup> producer after India
- 0.6 to 1.0 Mt/year
- $\pm$  10% downgraded and recycled in animal feeding
- Nutritional value in pigs?



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## Composition and amino acid profile of lentils

### Composition

g/kg	Lentil	Peas
Cr. protein	<b>24.5</b>	21
Starch	<b>36.5</b>	45
Oil	<b>1</b>	1
NDF	<b>15</b>	12
Ash	<b>3</b>	3

### Amino acid profile

% protein	Lentils	Peas	SBM	CM	Req
Lys	<b>6.1</b>	<b>7.3</b>	6.1	5.3	5.5
Thr	<b>4.1</b>	<b>3.8</b>	3.9	4.3	3.5
SAA	<b>2.0</b>	<b>2.3</b>	2.9	4.5	3.3
Trp	<b>1.0</b>	<b>0.9</b>	1.3	1.2	1.1



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SBM: soybean meal

CM: canola meal; Req: requirements

Sauvant et al (2004) INRA Tables, France

## Nutritional value of lentils in pigs

	Peas	Lentils
Ileal dig. Protein (%)*	73	63
DE (kcal/kg DM)	3,900	3,720
Estimated NE (kcal/kg DM)	2,685	2,600

\* Frozen lentils: 30%

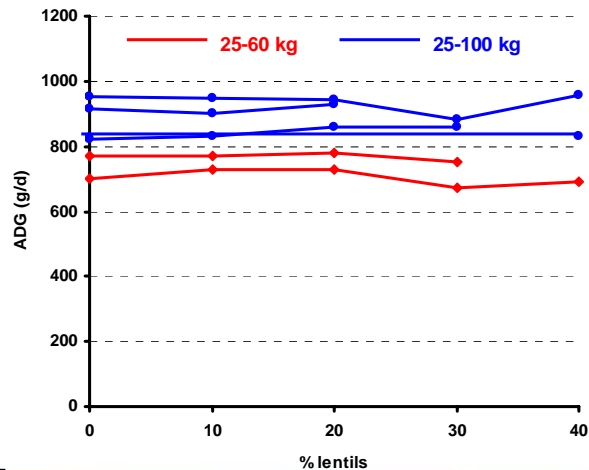


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Noblet et al (2007) JRP 39, 111

Leterme et al (2007) Pulse Days, Saskatoon, Jan 8-9

## ADG of pigs fed with increasing levels of lentils



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Castell & Cliplef (1988, 1990), Bell & Keith (1986)

## 3<sup>rd</sup> message

- Lentils have an energy value at least 5% lower than that of peas
- The proteins are lower in essential amino acids than peas and have a lower digestibility
- Freezing before harvest decreases protein digestibility
- Pigs can tolerate up to 40% of lentils in their diet



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## Flaxseed and flaxseed meal

- *Linum usitatissimum*

- Fibre (linen)
- Seed (oil)
  - **industry**
    - soap
    - vinyl, ...
  - **human nutrition**
    - high-omega-3 oil
    - flaxseed
  - **animal nutrition**
    - flaxseed meal



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## Composition of flaxseed (meal) and amino acid profile

### Composition

g/kg	Flax seed	Flax meal	Canola meal
Cr. protein	22	31	34
Oil	33	8	3
NDF	22	30	28
Ash	4.5	6	7
Lignin	4	6	9.5

### Amino acid profile

% protein	Flax	SBM	CM	Req
Lys	3.7	6.1	5.3	5.5
Thr	3.7	3.9	4.3	3.5
SAA	3.6	2.9	4.5	3.3
Trp	1.5	1.3	1.2	1.1

SBM: soybean meal

CM: canola meal; Req: requirements

Sauvant et al (2004) INRA Tables, France



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## Nutritional value of flaxseed and flaxseed meal in pigs

Comparison with soybean and canola meal

	Flax	FSM*	SBM	CM
DE (kcal/kg)	4200	3100	3450	2800
NE (kcal/kg)	3130	2000	1920	1510
d protein	79	78	88	74

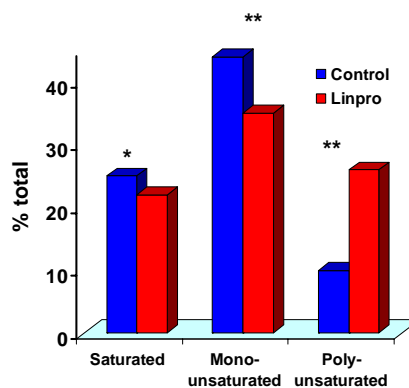
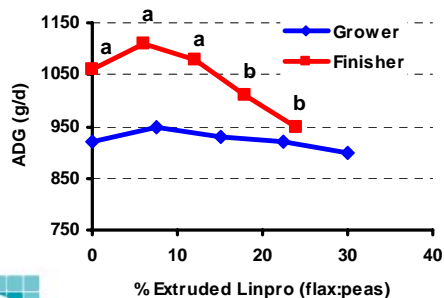
Flax: flaxseed, FSM: flaxseed meal  
 SBM: soybean meal; CM: canola meal  
 FSM: flaxseed meal with 8% fat



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Sauvant et al (2004) INRA Tables, France

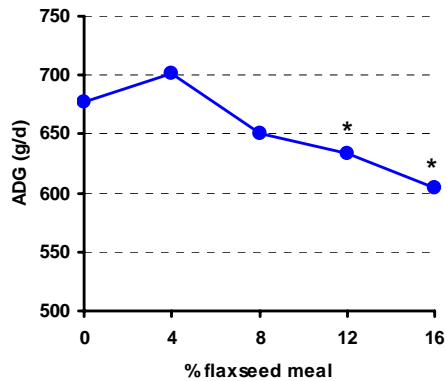
## Effect of a mixture of extruded flaxseed and peas on average daily gain and carcass fat composition



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Thacker et al (2004) Can. J. Anim. Sci. 84, 681

## Effect of flaxseed meal on average daily gain in pigs



Control diet: 77% cereal-10% SBM; Increase in FSM at the expense of SBM  
Supplementation in Lysine only



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Bell & Keith (1993) Anim. Feed Sci. Technol. 43, 1-18

## 4<sup>th</sup> message

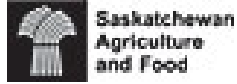
- Flaxseed has the highest level of omega-3 fatty acids in the plant kingdom
- The intake of flaxseed increases the level of polyunsaturated fat in the pig carcasses
- The proteins of flaxseed are deficient in lysine but high in tryptophan
- Flaxseed and flaxseed meal can represent up to 10% of the diet of growing pigs



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# Acknowledgements

## Program sponsors



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## Project sponsors

