Use of biofuel co-products in pigs - economics and nutritional limitations

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crop protection

environmental advisory service

grain storage

grain marketing

KW Trident

straights, blends, moist feeds, molassed beet

Ireland – grass seed, silage additives, alternative feeds

audit services for dairy crest milk producers

Farm Wildlife Habitat Scheme

MAKING SPACE FOR WILDLIFE

specialist nutrition

Primary Diets

feed ingredients

enzymes, yeast et al

ABN

compound feed

pig marketing

Sullivan Poultry Group

poultry marketing

Biofuel co-products

- **Bio ethanol**
  - Distillers dried grains + solubles (DDGS)
    - Maize
    - Wheat
- **Bio diesel**
  - Rape seed meal
  - Glycerol

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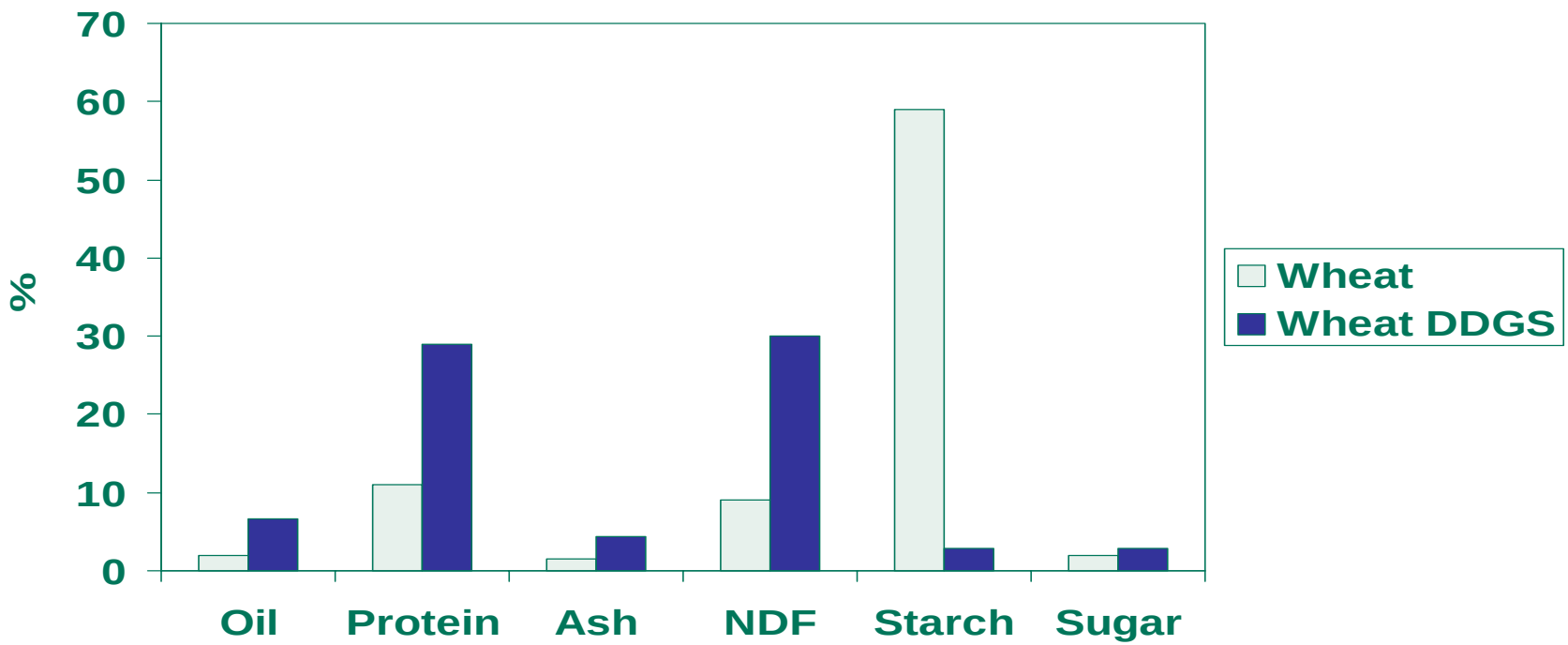
Main limitation in the use of DDGS is the variation in nutrient content

- Source of variation:-
  - Incoming raw material
  - Addition of condensed distillers solubles
  - Quantity of starch removed
  - Temperature and duration of drying process
  - Mycotoxin content

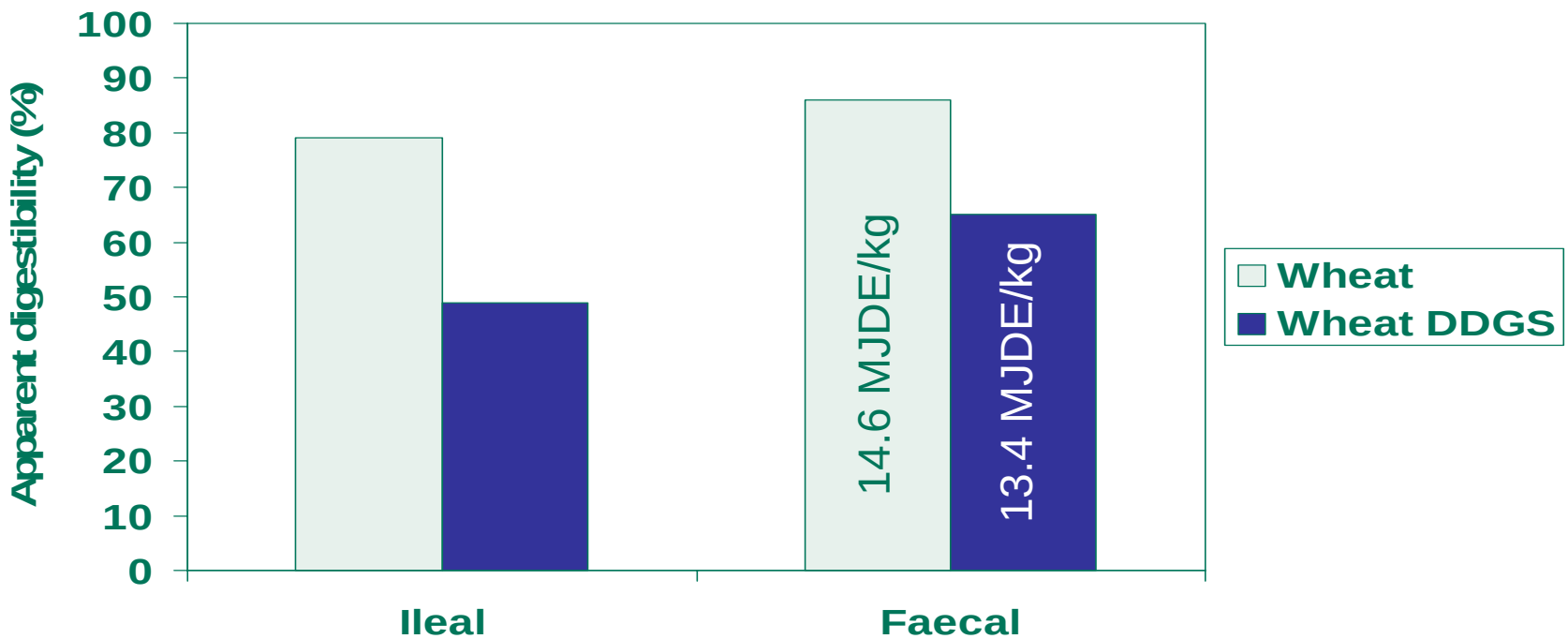
(Shurson *et al*., 2004)

Wheat and wheat DDGS - nutrient analysis



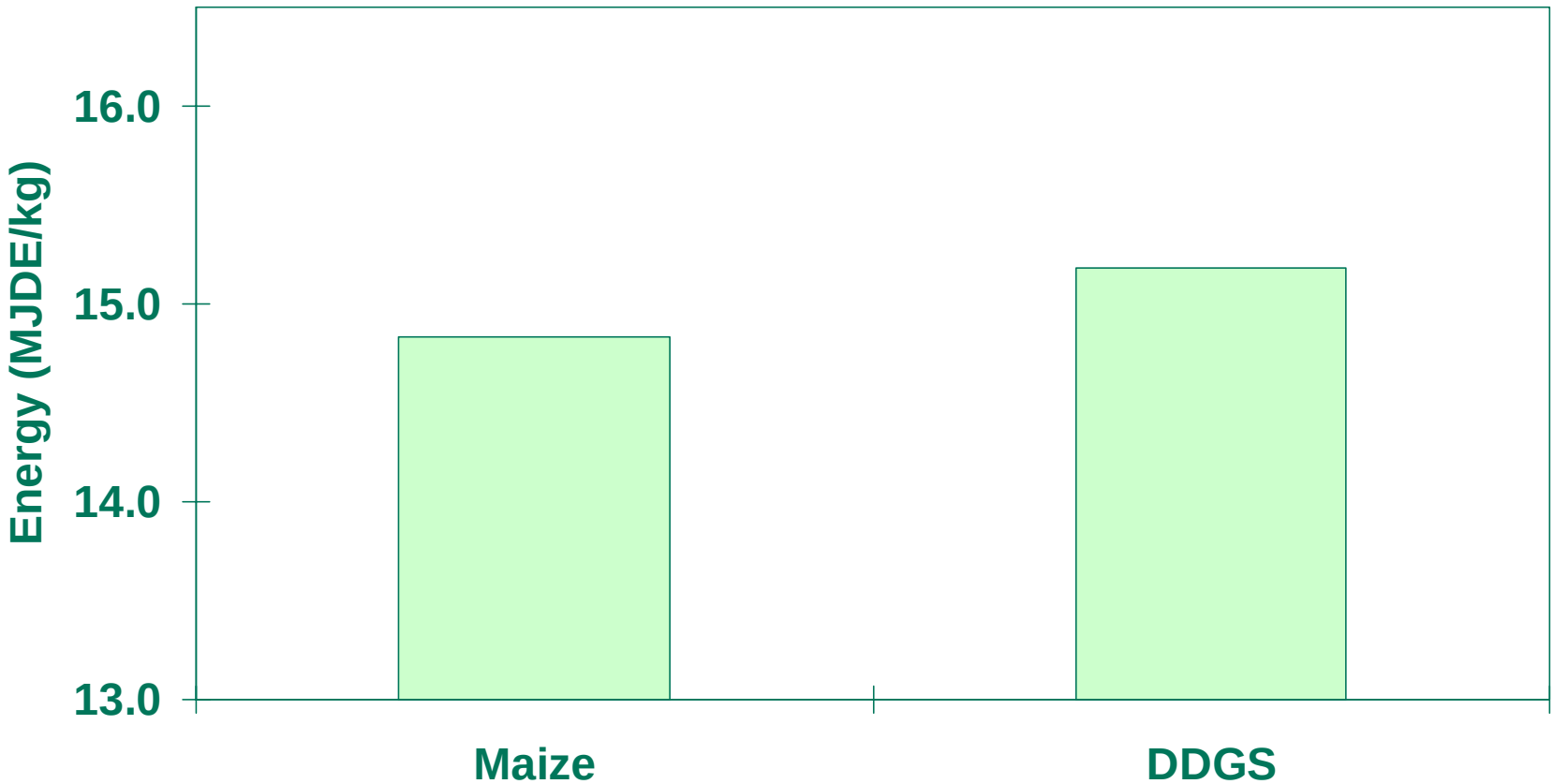
(1 tonne wheat gives 0.33 tonnes DDGS)

Wheat DDGS has a lower energy digestibility than wheat



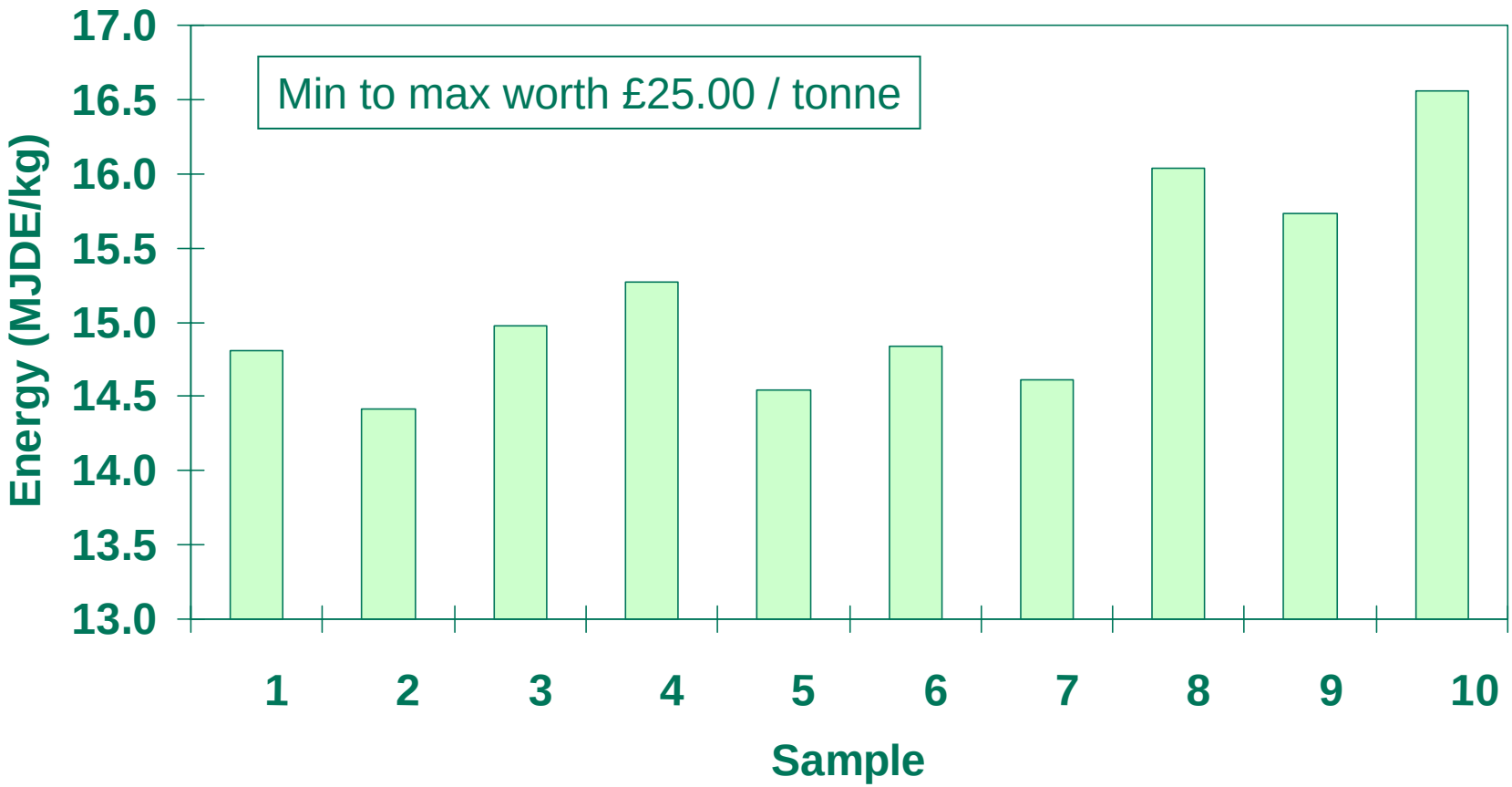
(Nyachoti *et al*., 2005)

The DE value of maize DDGS is similar to maize



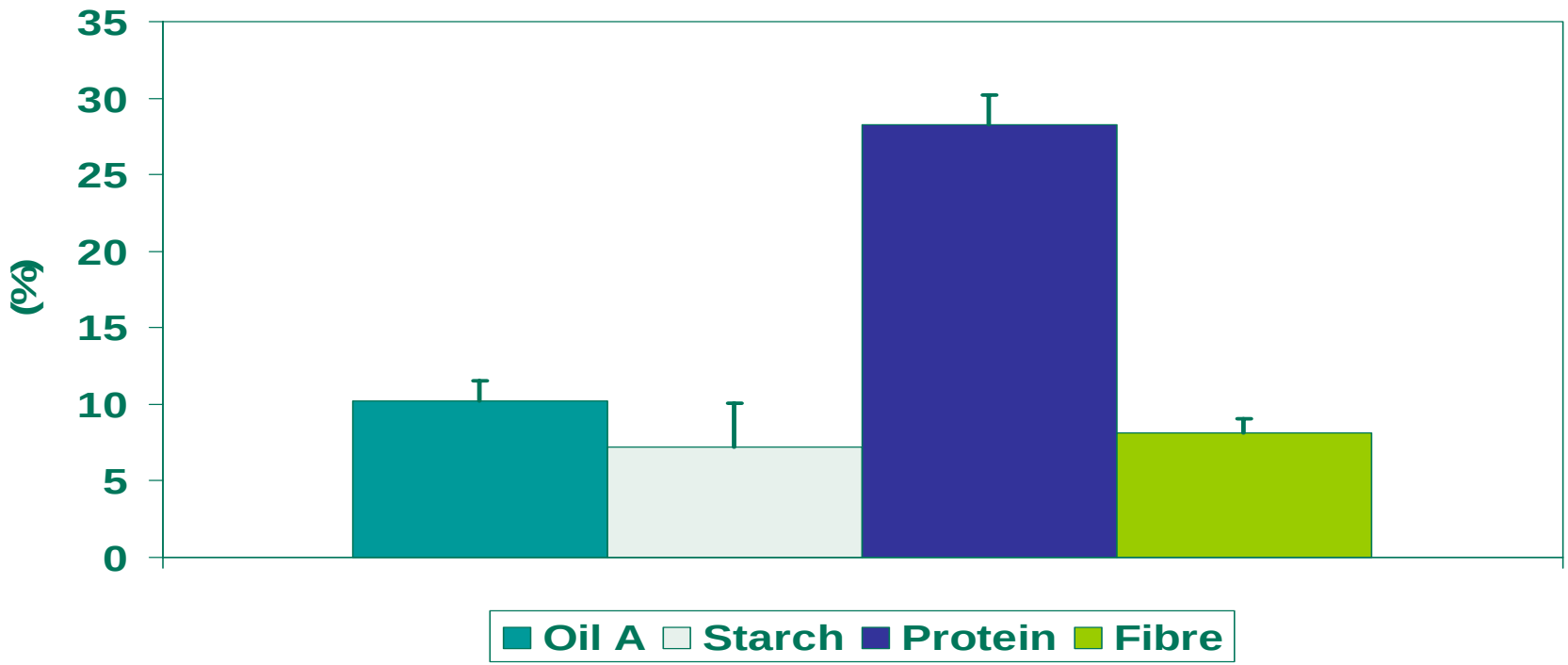
(Adapted from Pedersen et al., 2007)

The DE value of maize DDGS is variable



(Pedersen et al., 2007)

Maize DDGS shows greatest variation in starch analyses



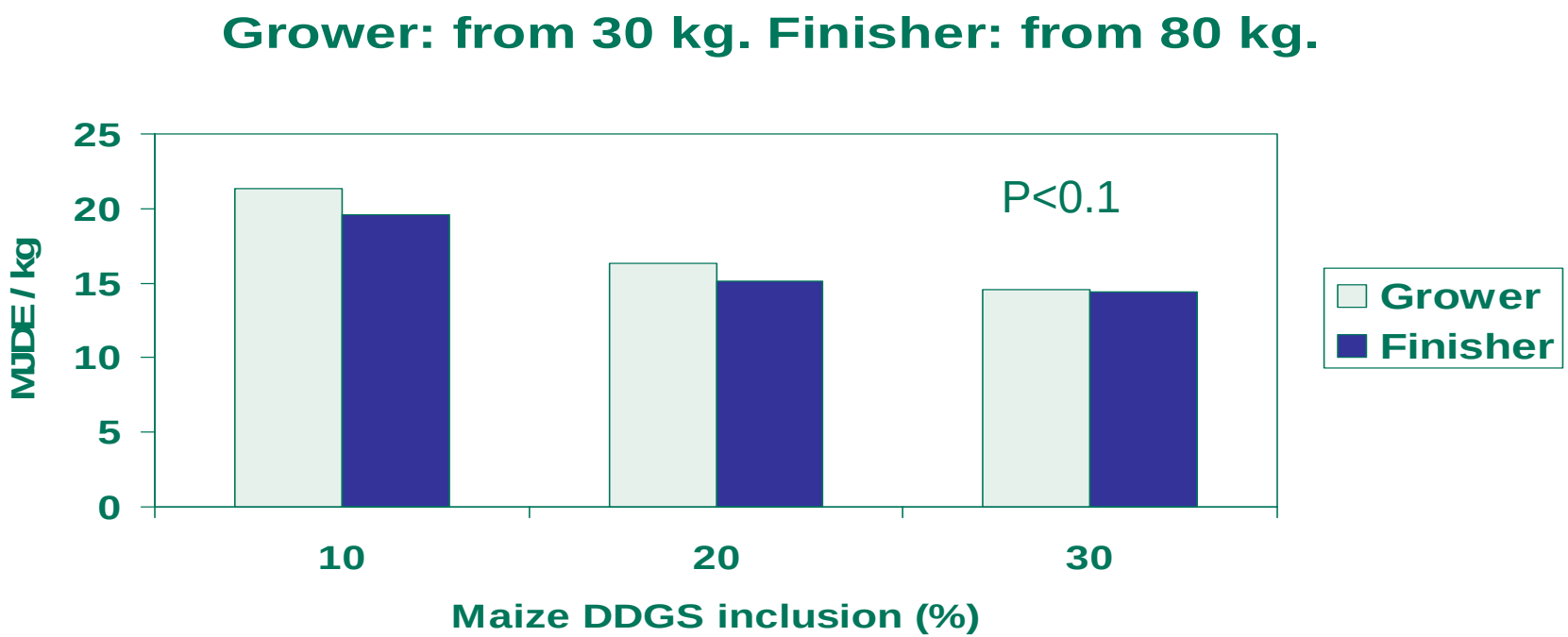
(Pedersen *et al*., 2007)

Maize DDGS has a lower NE than maize

(Calculated from Pedersen *et al*., 2007)

NE (MJ/kg) = 0.703 x DE (MJ/kg) + 0.066 x EE (%) + 0.02 x Starch (%) – 0.041 x (Protein (%) + Fibre (%)) (Noblet, 2005)

Maize DDGS tends to have a lower DE at higher inclusions



(Adapted from Shurson et al., 2001)

DDGS shows high phosphorus digestibility

	Wheat		Maize	
	Grain	DDGS	Grain	DDGS
Total phosphorus (%)	0.34	0.65	0.20	0.61
Apparent digestibility (%)	18.8	49.4	19	59

(Adapted from Pedersen *et al*., 2007 and Widyaratne, 2005)

Wheat DDGS has a low phytate content

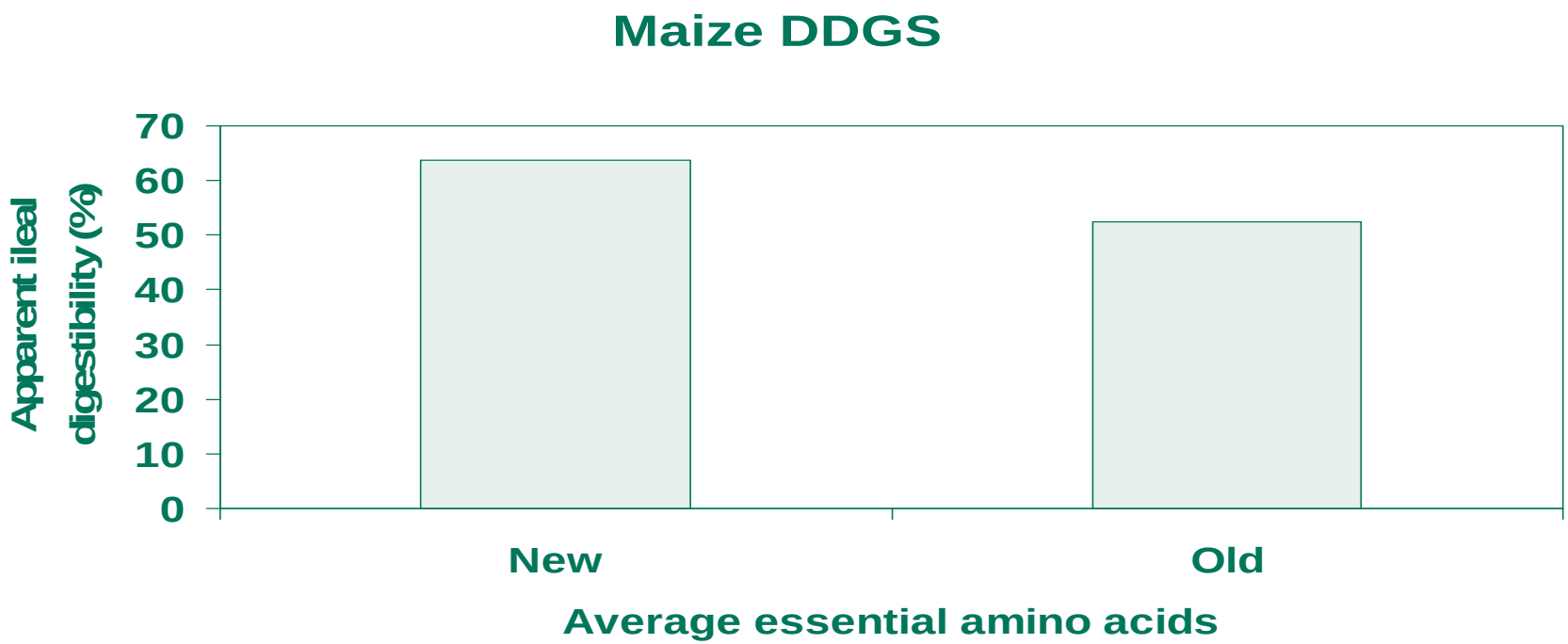
(Adapted from Widyarante and Zijlstra, 2007)

The standardised ileal amino acid digestibility of DDGS is lower than grain

	Maize[1]		Wheat[2]	
	Grain	DDGS	Grain	DDGS
Lys	68	57	78	64
Met	84	79	88	84
Thr	74	67	85	78
Try	73	77	91	86
Iso	78	72	89	81
Leu	85	80	89	85
Val	77	71	92	87

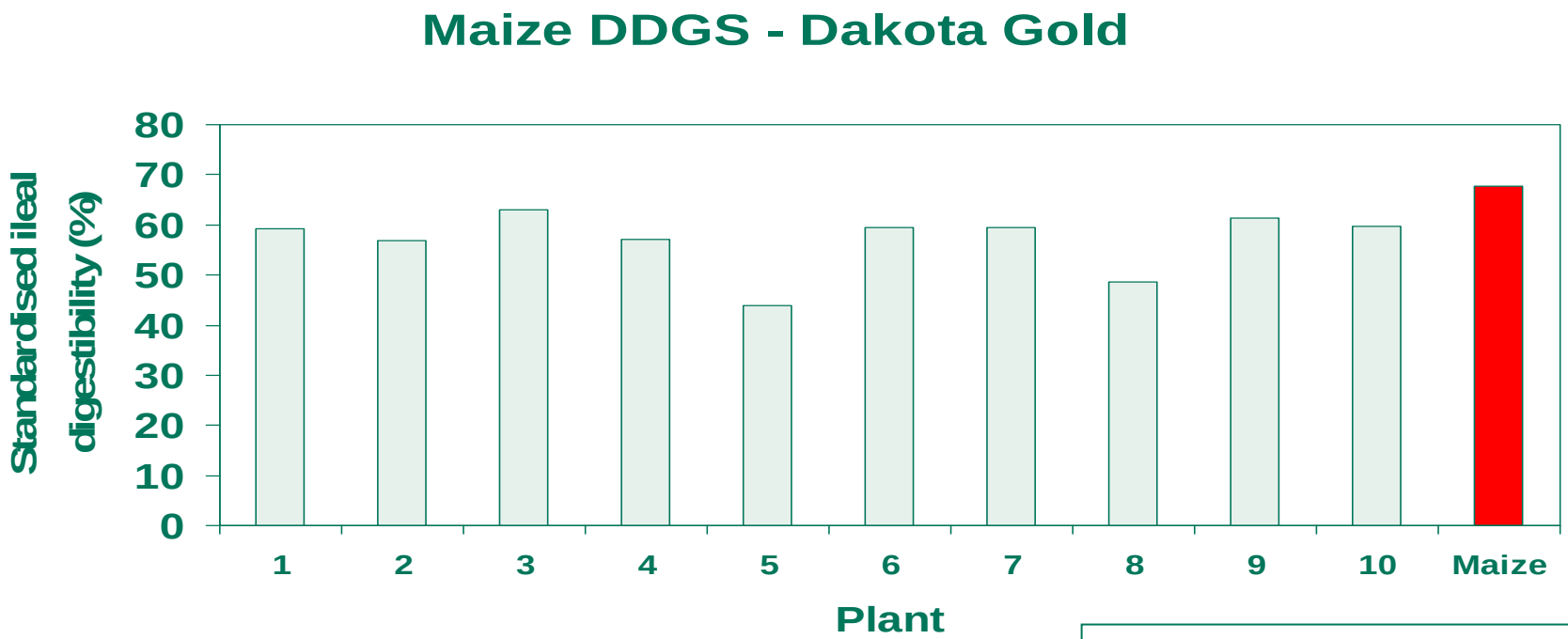
(Adapted from [1] Stein et al., 2006; [2] Widyaratne and Zijlstra, 2007)

New plants tend to give a higher amino acid digestibility



(Adapted from Shurson *et al*., 2007)

New plants continue to show variation in lysine digestibility



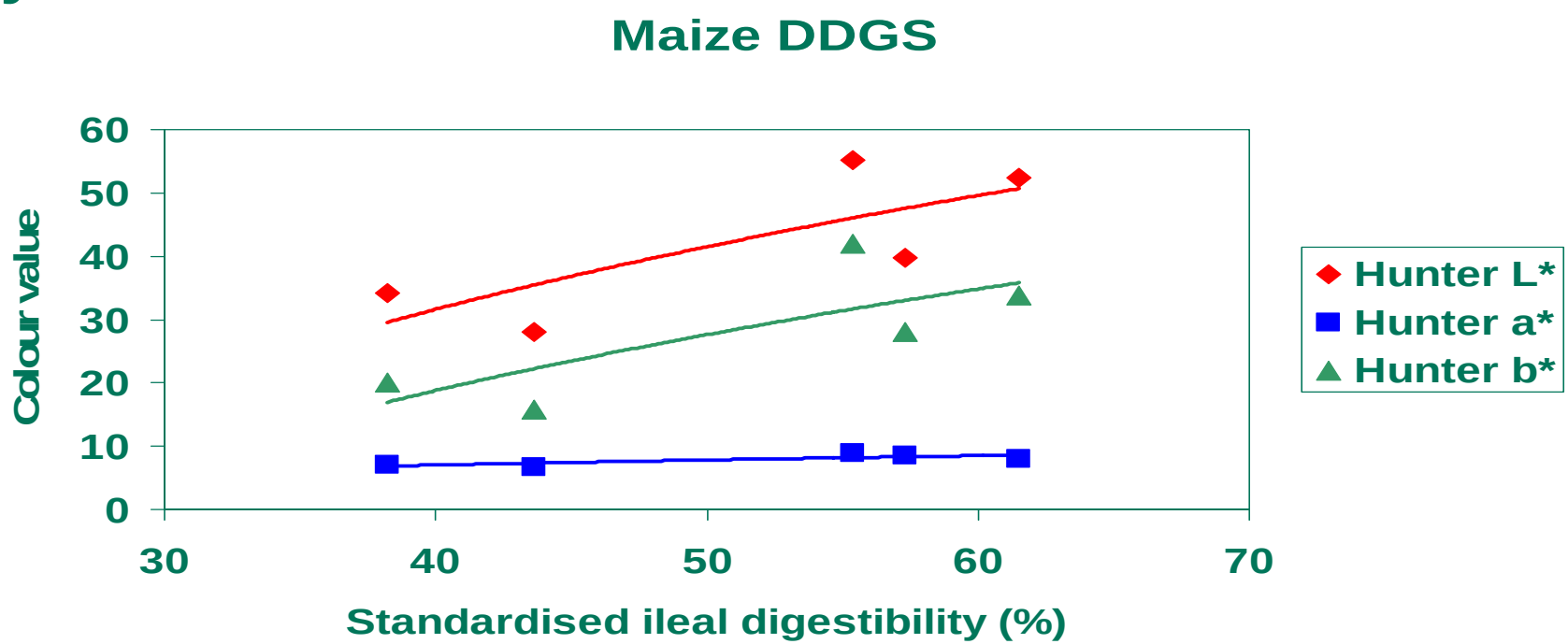
(Stein *et al*., 2006)

Maize vs. DDGS P=0.001
DDGS P=0.001

Methods of assessing amino acid digestibility *in vitro*

- Colour measurements (maize DDGS)
- Ratio of lysine to protein
  - >2.8 % (Stein, 2007)

Hunter colour score correlates with digestible lysine

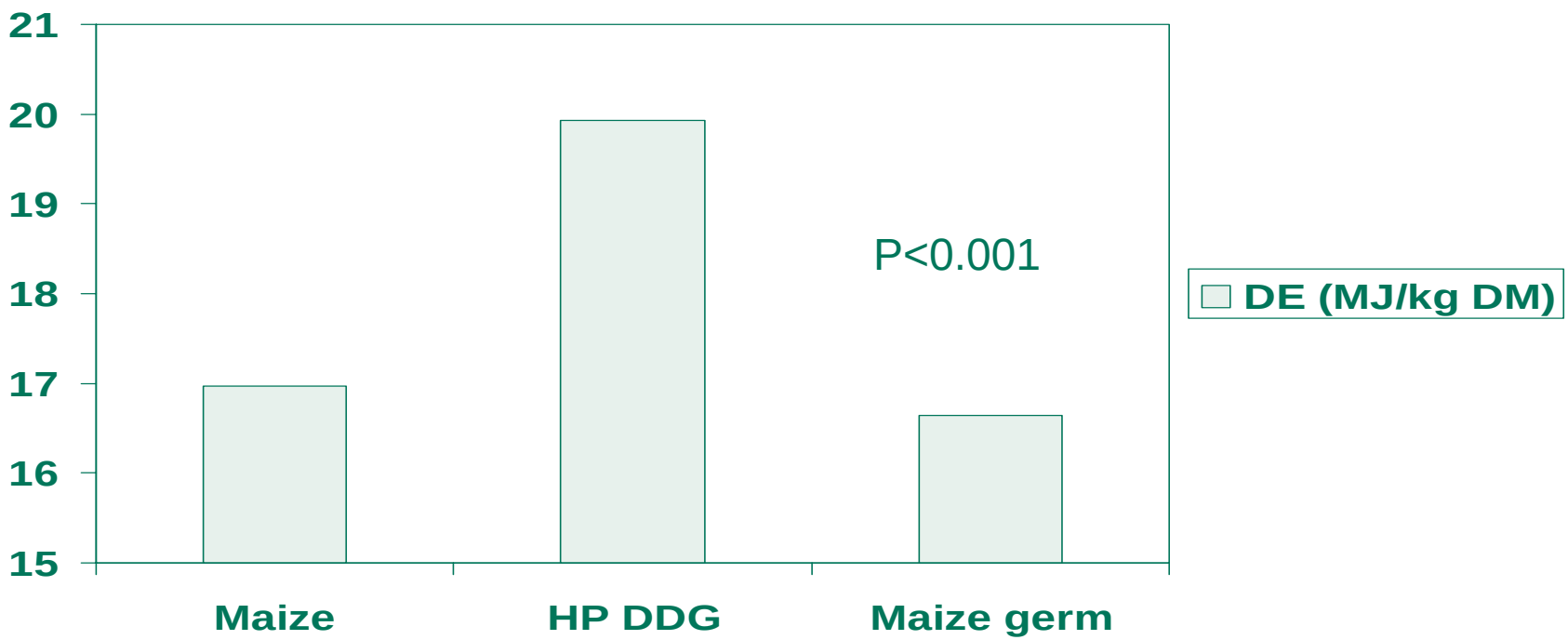


(Fastinger and Mahan, 2006)

New technologies

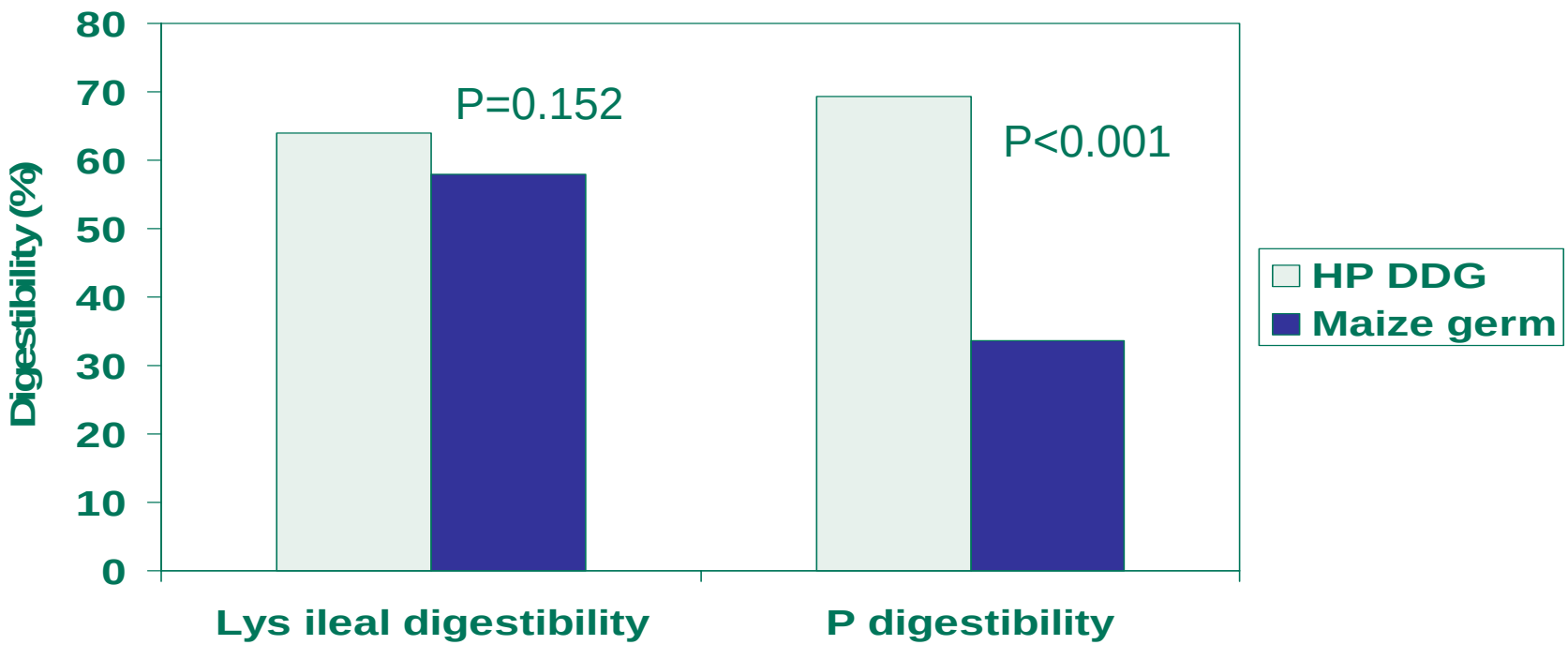
- Enzymes
  - Research is progressing in this area but few results have been published to date
  - Increased energy digestibility has been indicated
- Process refinements
  - High-protein distillers dried grain (Maize)
  - Process
    - Broin Companies using BFrac
    - Dehulled and degermed maize prior to fermentation
    - Solubles not added back

DE of HP DDG



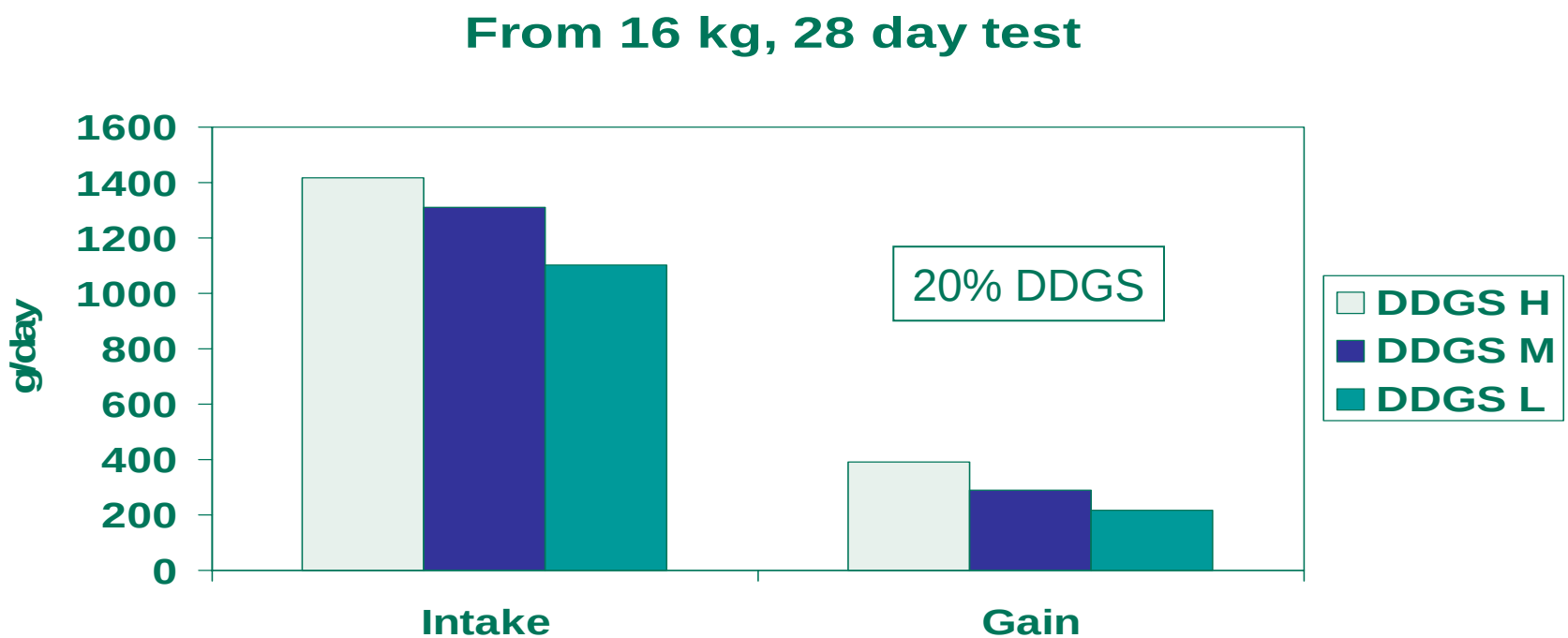
(Widner *et al*., 2007)

HP DDG digestibility



(Widner *et al*., 2007)

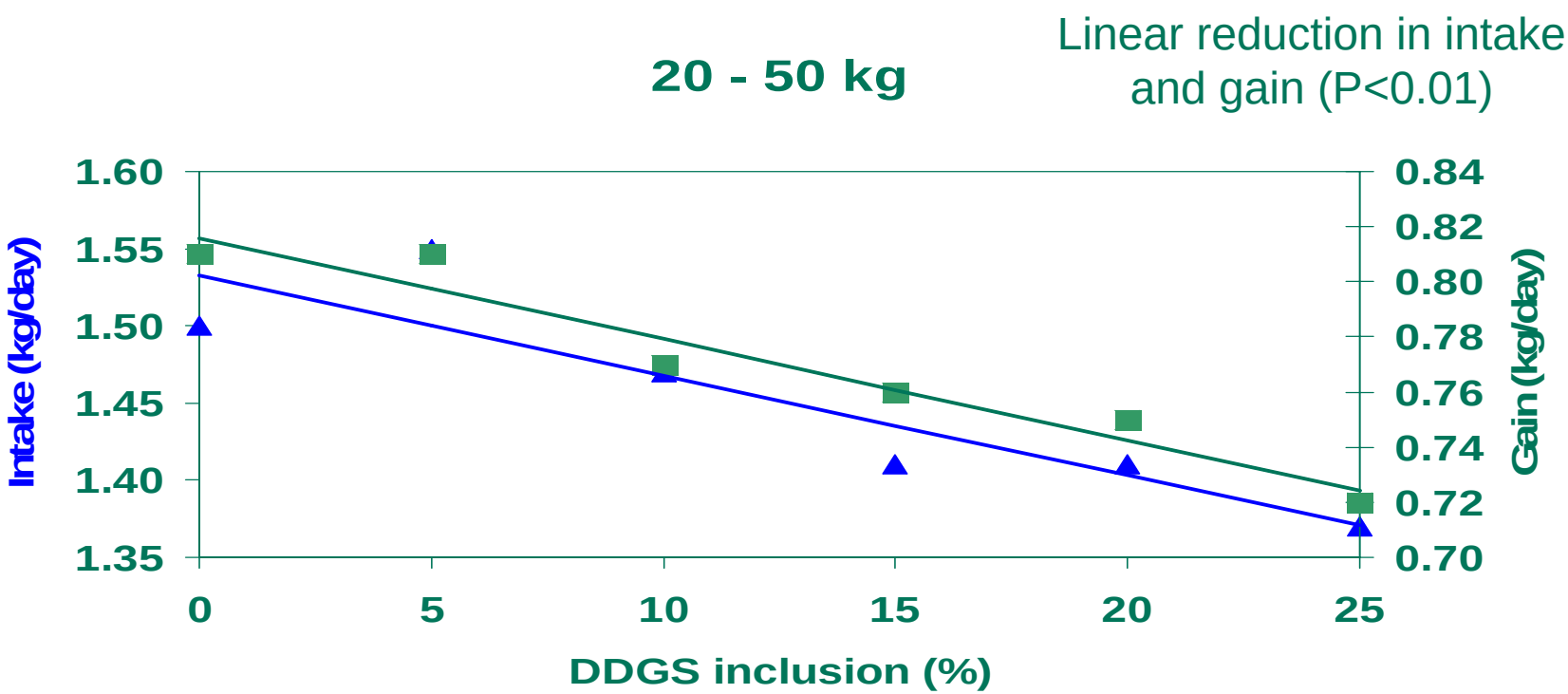
Digestibility of maize DDGS affects intake and gain



(Adapted from Cromwell et al., 1993)

Wheat DDGS reduced growth and intake

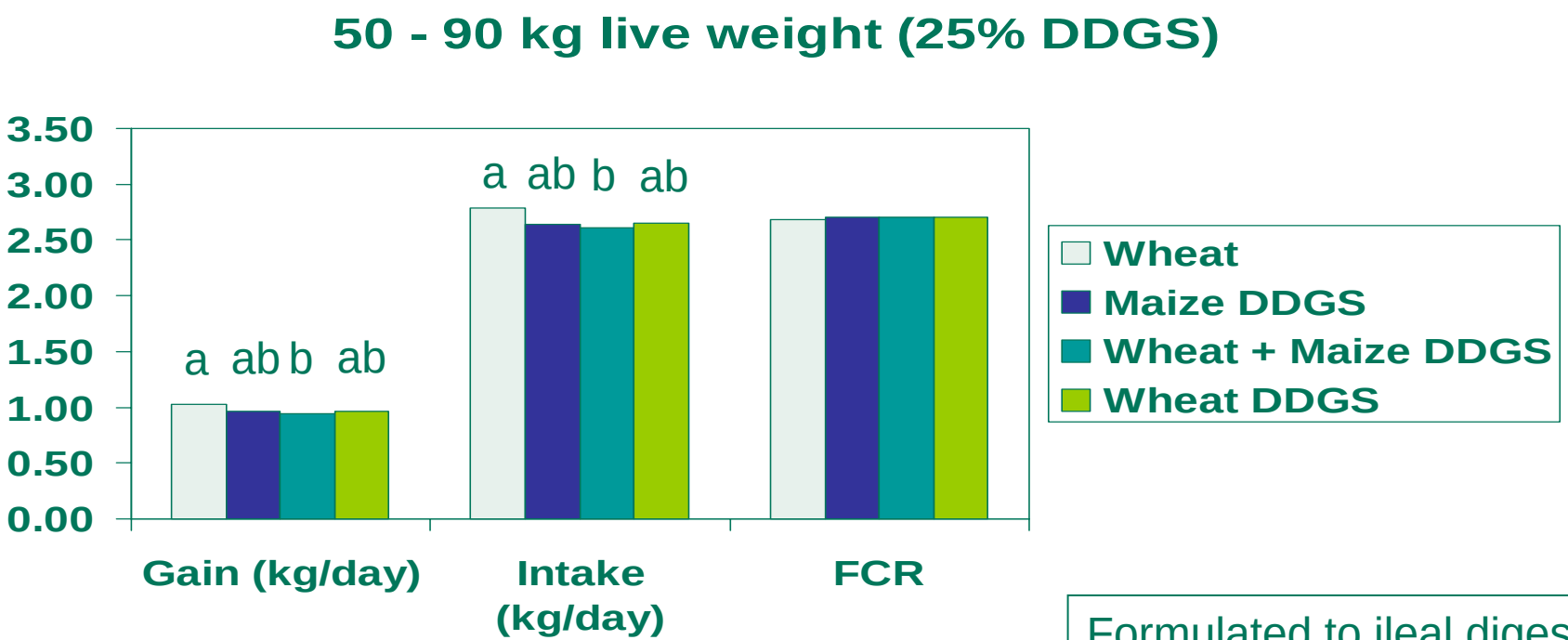
Linear reduction in intake and gain (P<0.01)



(Thacker, 2006)

[Formulated using total amino acid values]

DDGS has a slight effect on performance above 50 kg live weight



(Widyaratne, 2005)

Formulated to ileal digestible amino acids

Potential reasons for performance reduction

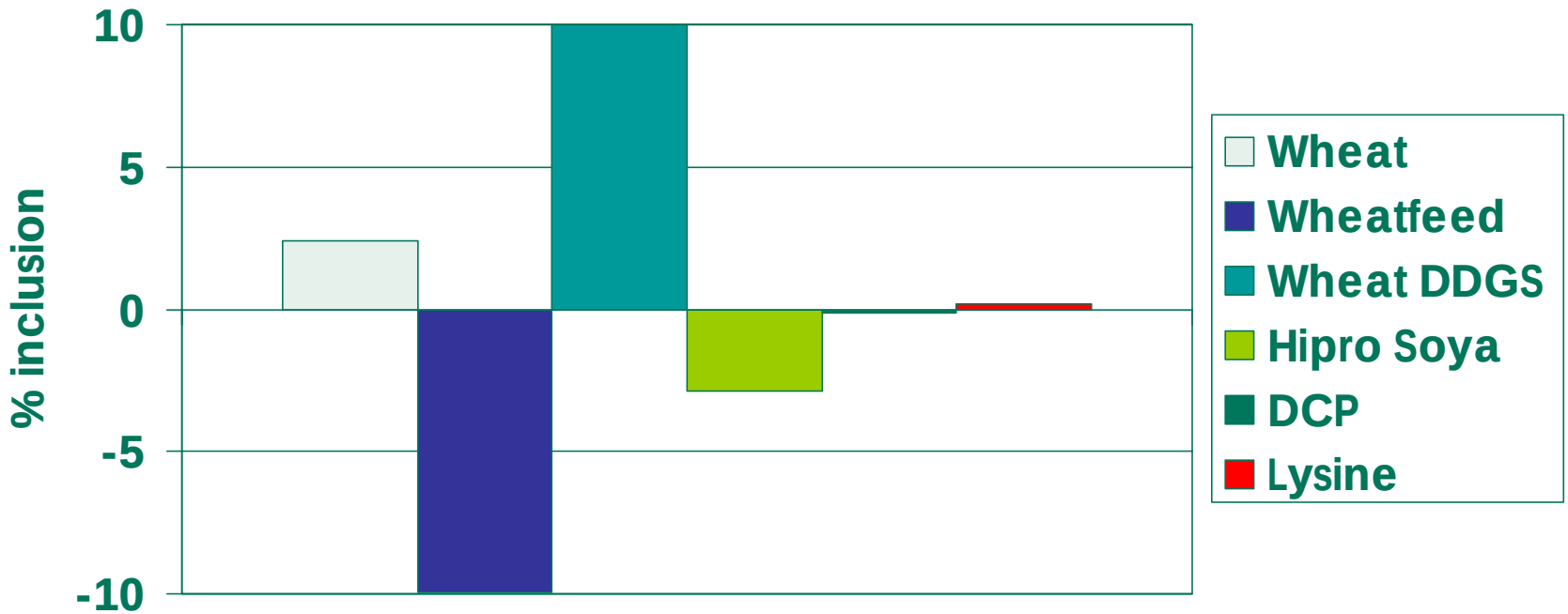
- Formulating to total amino acids
  - Not accounting for digestibility
- High fibre levels
  - Reduction in intake due to limitation of gut volume
  - Reduced killing out percentage due to larger gut mass

DDGS inclusion levels

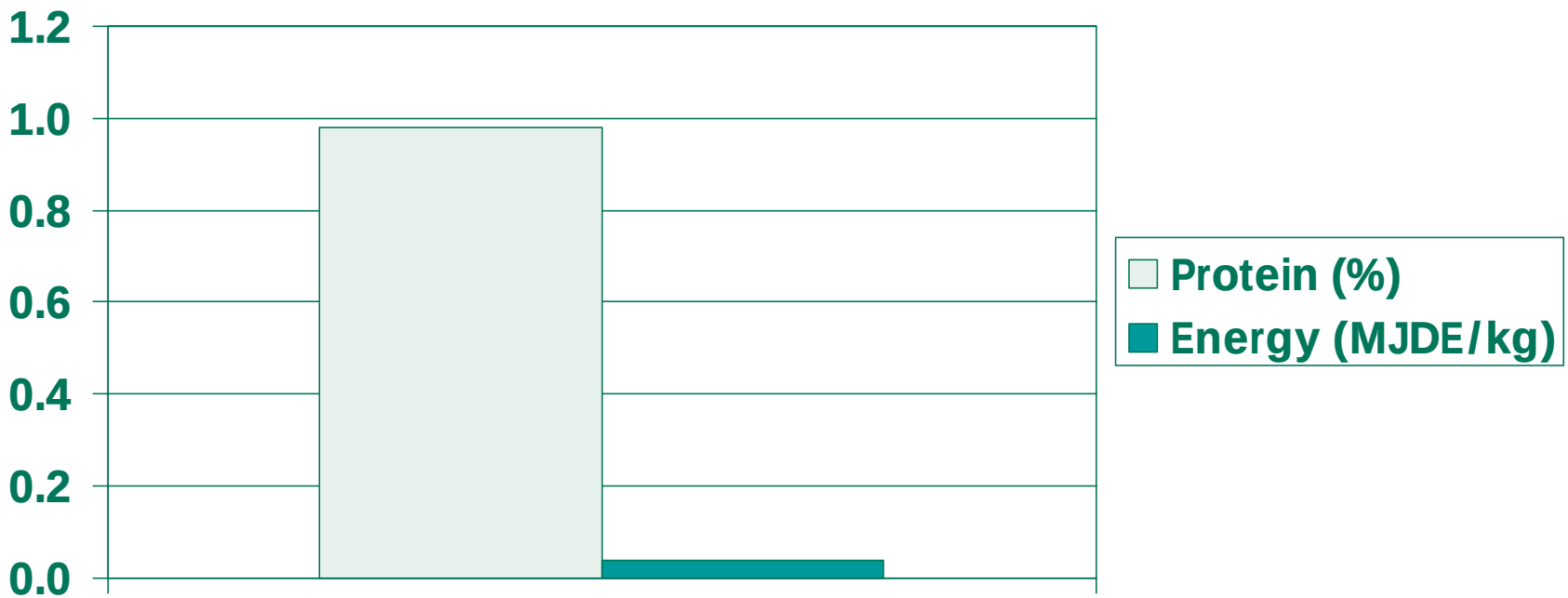
Stage	Maize DDGS*	Wheat DDGS
>7 kg	5 -10%	?
Growing - Finishing	10 - 20%	5 – 10%
Gestation	<50%	5 – 10%
Lactation	<20%	?

*(Koster, 2007)

Wheat DDGS replaces wheatfeed and soya



Wheat DDGS increases dietary protein



Summary of DDGS

- Nutrient analysis and digestibility
- In vitro methods of predicting digestible amino acids
- New technologies
- Effect of inclusion on performance and diet composition

Biofuel co-products

- **Bio ethanol**
  - Distillers dried grains + solubles (DDGS)
    - Maize
    - Wheat
- **Bio diesel**
  - Rape seed meal
  - Glycerol

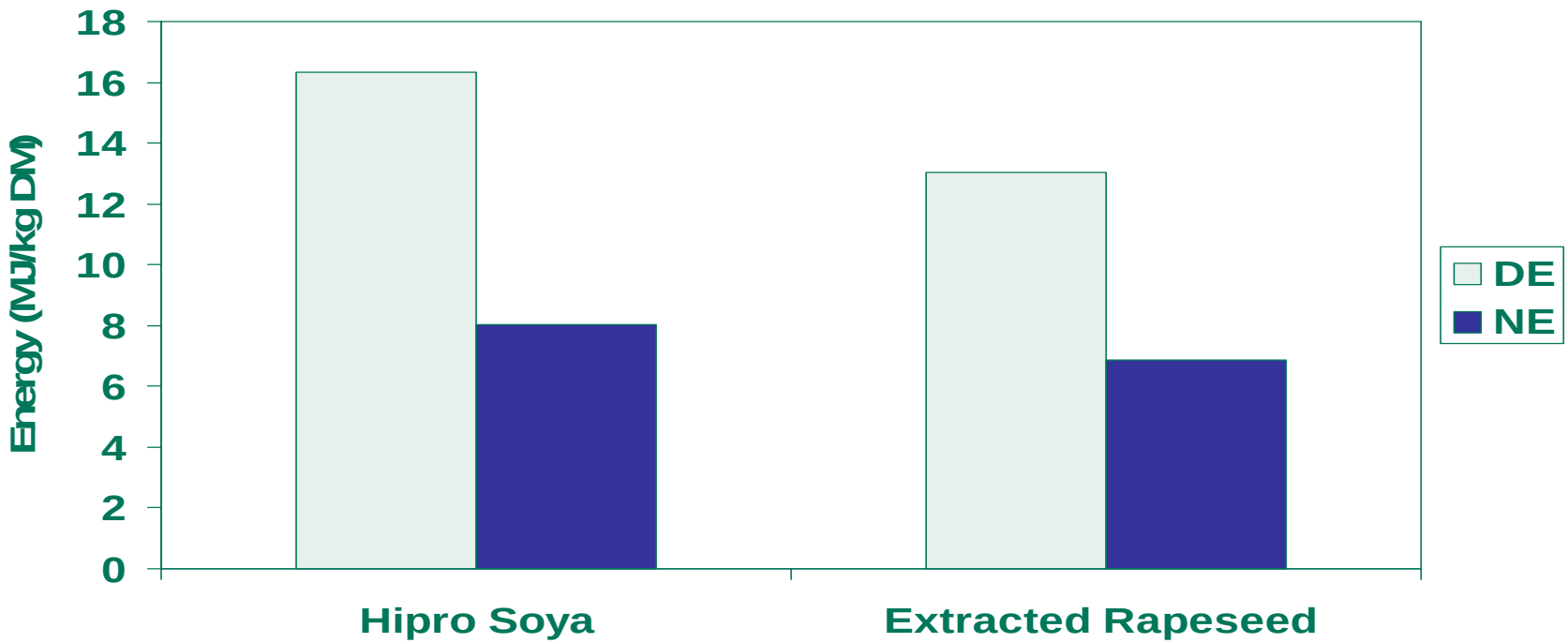
www.treehugger.com

Analysis of rapeseed products

	Soya 48%	Rapeseed - extracted	Rapeseed - expeller
Protein %	48	32-35	31-34
Oil %	2.0	2.5-3.5	7-13
Fibre %	3.7	5.4-5.8	10-15
SID lysine (%)	89-92	72-80	72-79
Glucosinolate (μM/g)		8.3 (4 – 31)	16.6 (8 – 62)

(Adapted from Doppenberg and van der Aar, 2007)

Comparison between energy values of hipro soya and rapeseed meal



(Noblet et al, 1992)

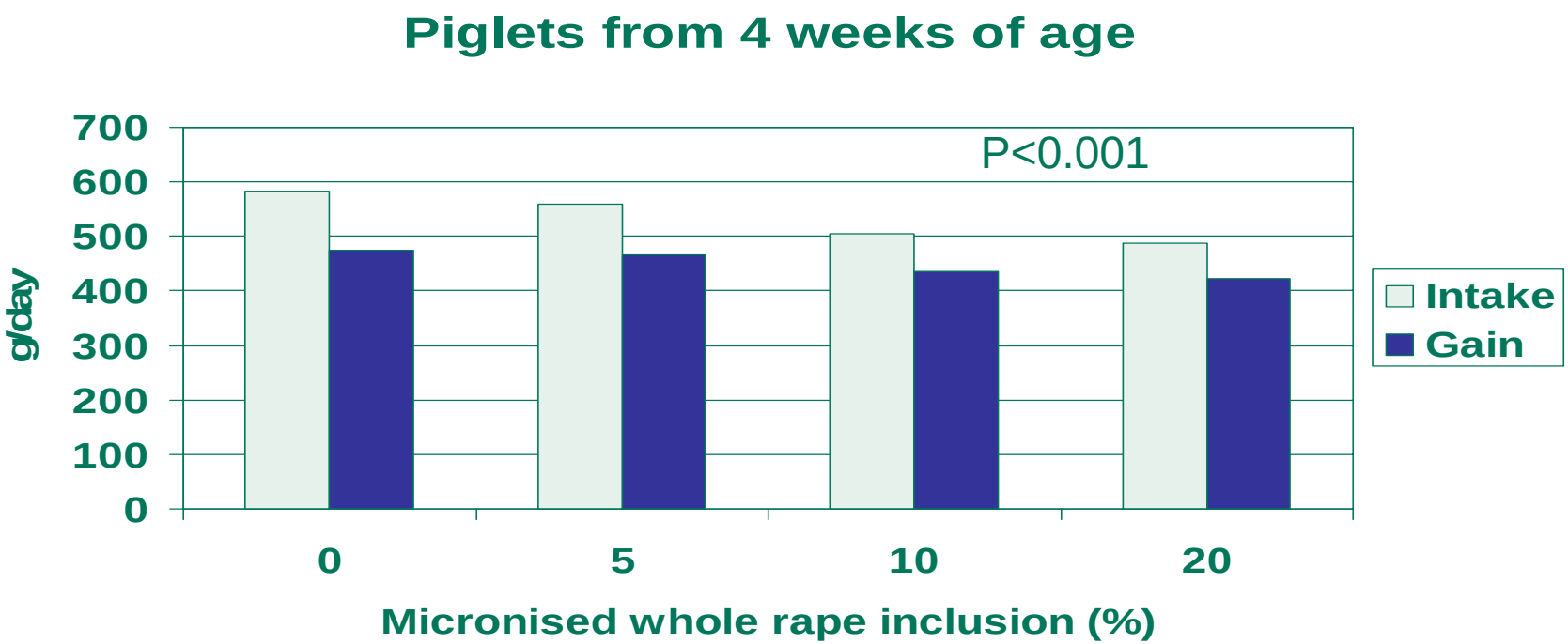
Rapeseed anti-nutrients

- Erucic acid
  - Single zero ‘0’
- Glucosinolates
  - Double zero ‘00’
- Tannins
  - Triple zero ‘000’

Glucosinolates can reduce performance

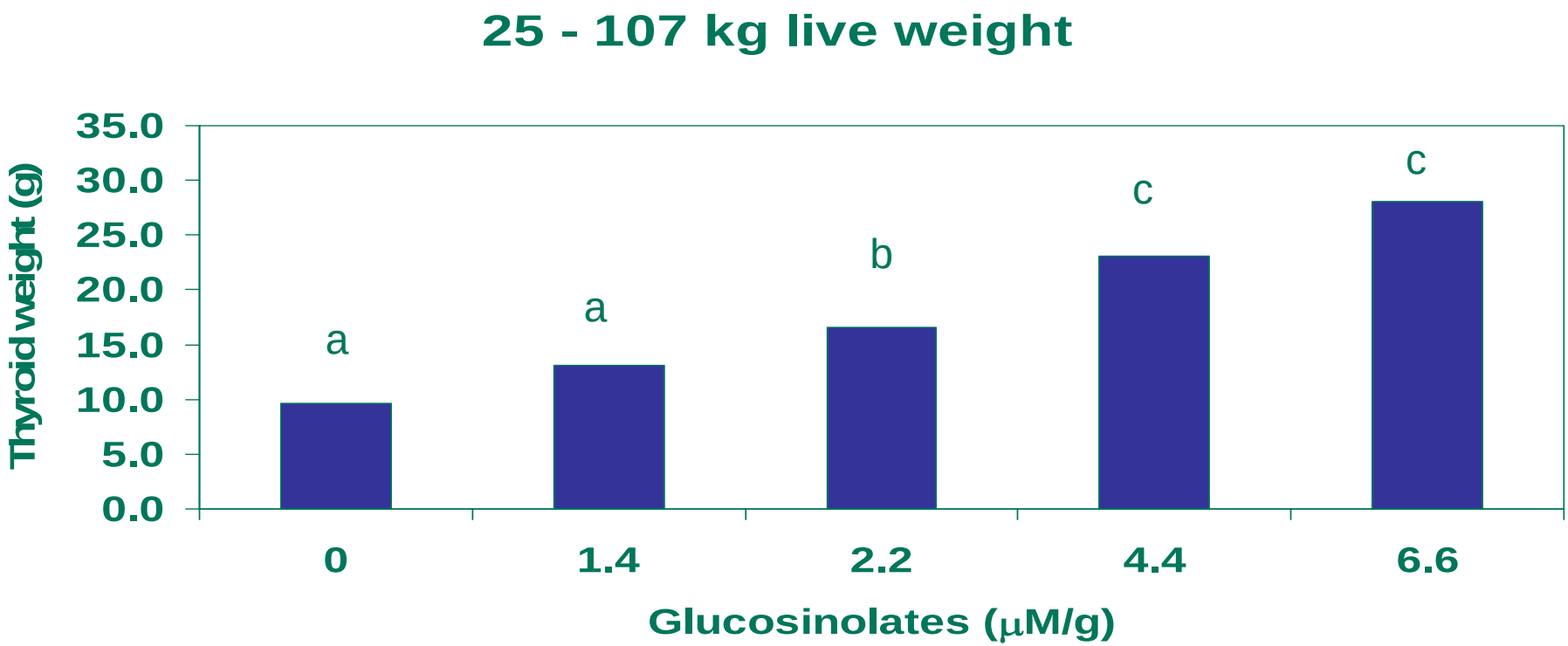
- Reduced intake
- Growth depression
- Iodine deficiency
- Liver and thyroid gland hypertrophy

Rape seed reduced intake and gain in piglets



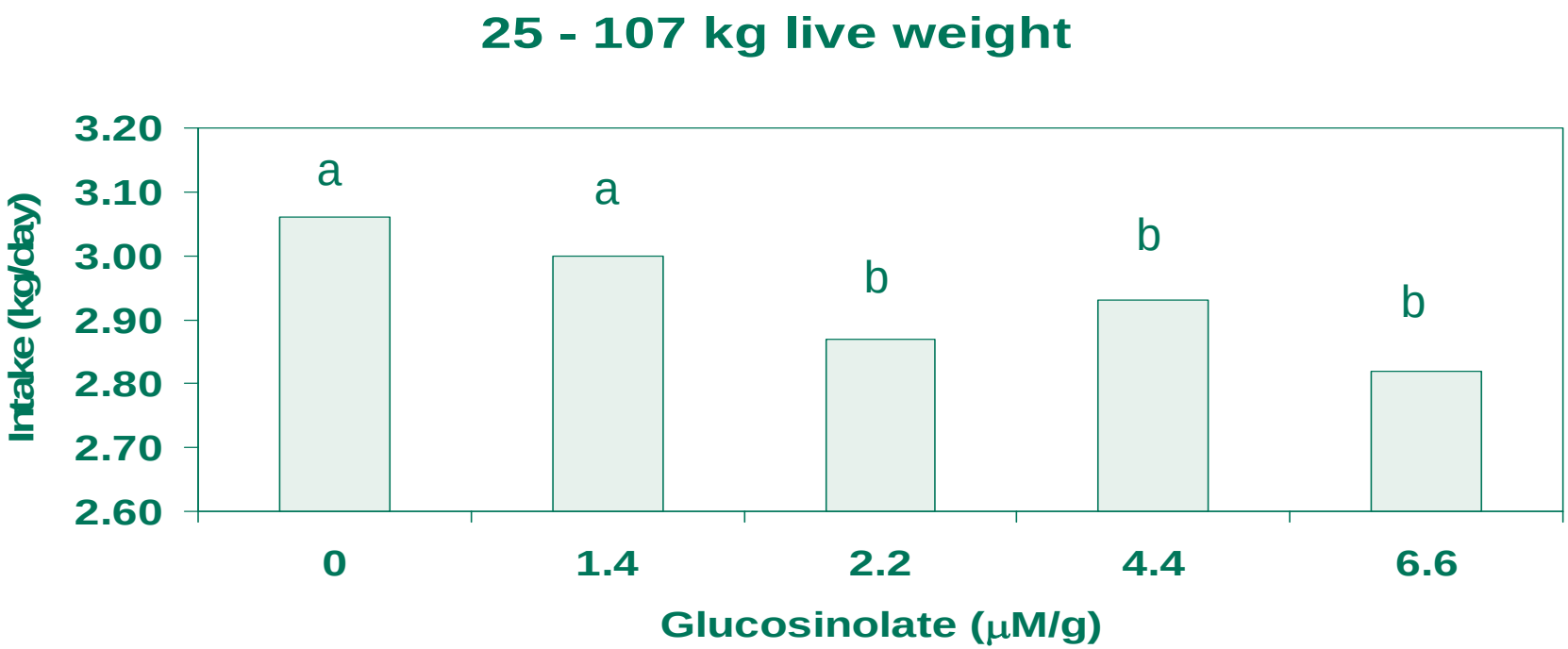
(Wattanakul *et al*. 2006)

Glucosinolates increase thyroid weight in growing pigs



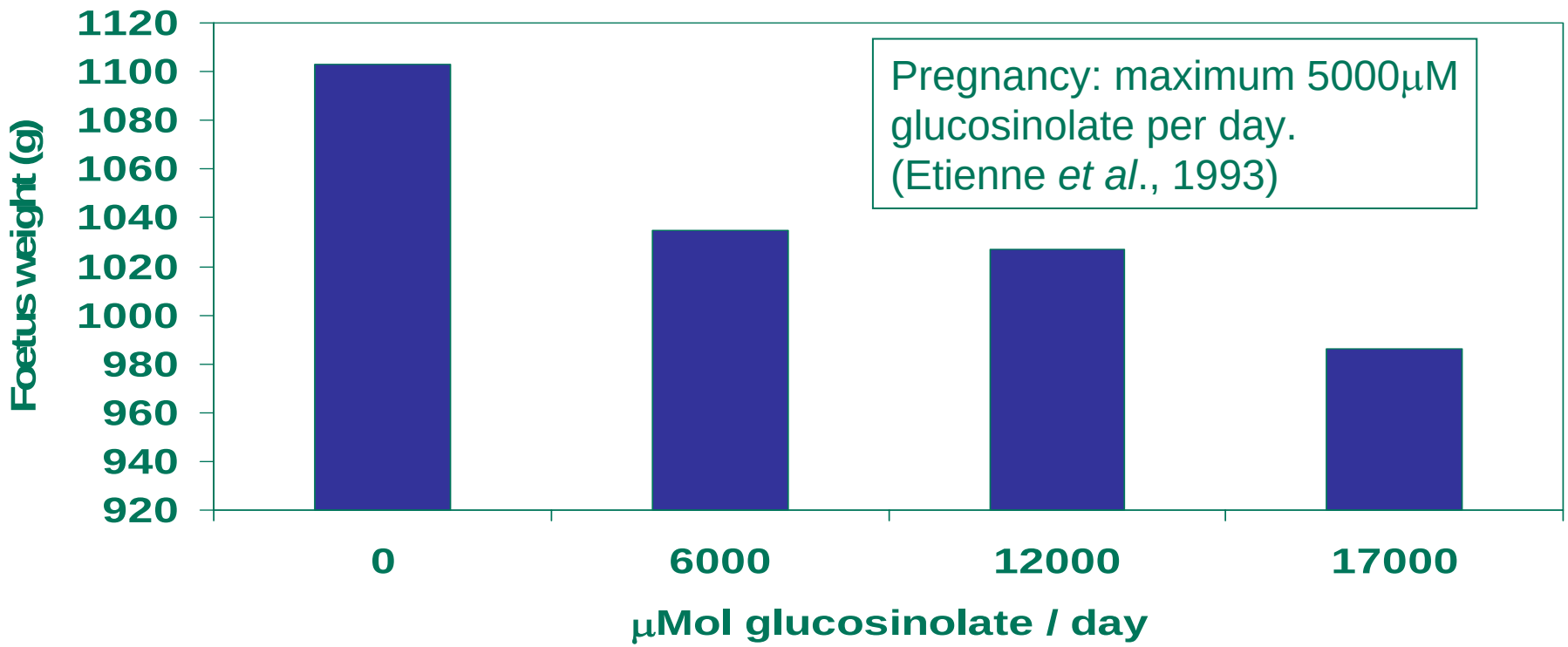
(Borggreve and Veldman, 1989)

Glucosinolates reduce feed intake



(Borggreve and Veldman, 1989)

Increased glucosinolates in gestation diet decreased foetus weight



(Etienne et al., 1991)

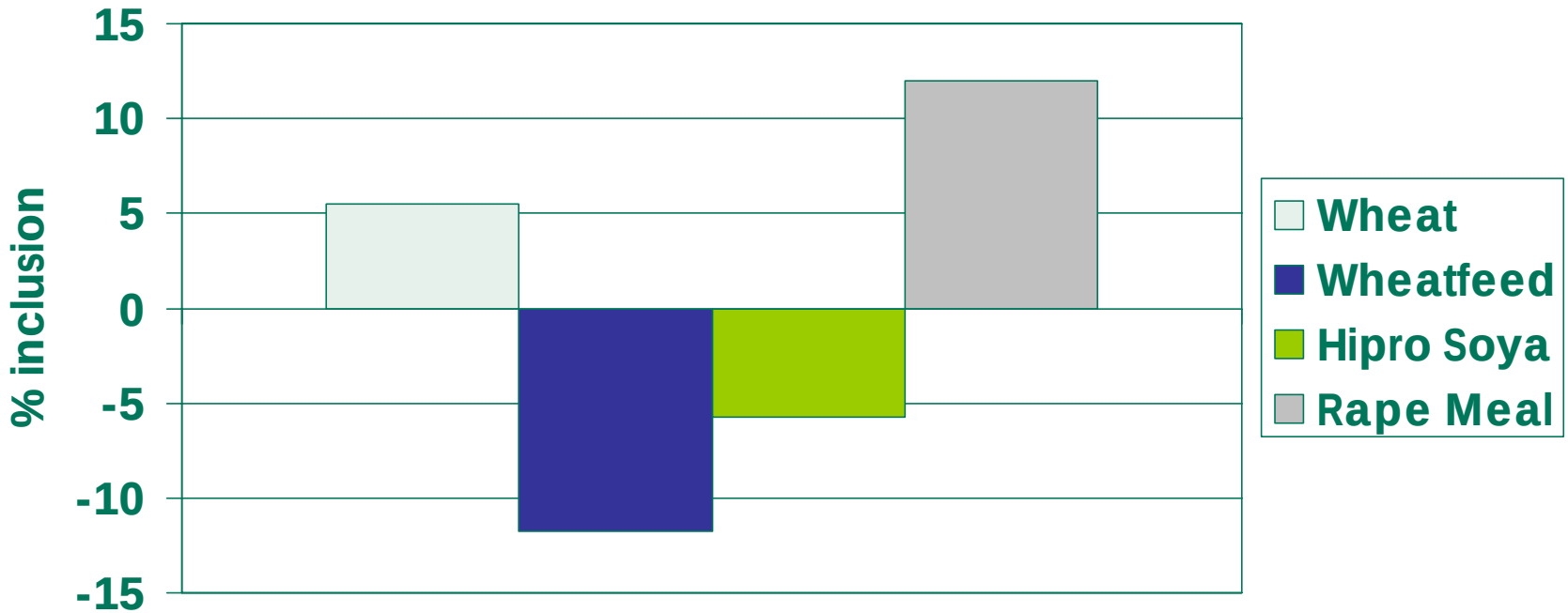
Extracted rape seed meal inclusions

	'00' Rapeseed meal level (% feed)
Grower	12.0
Finisher	12.0
Dry Sow	10.0*
Lactating Sow	12.0

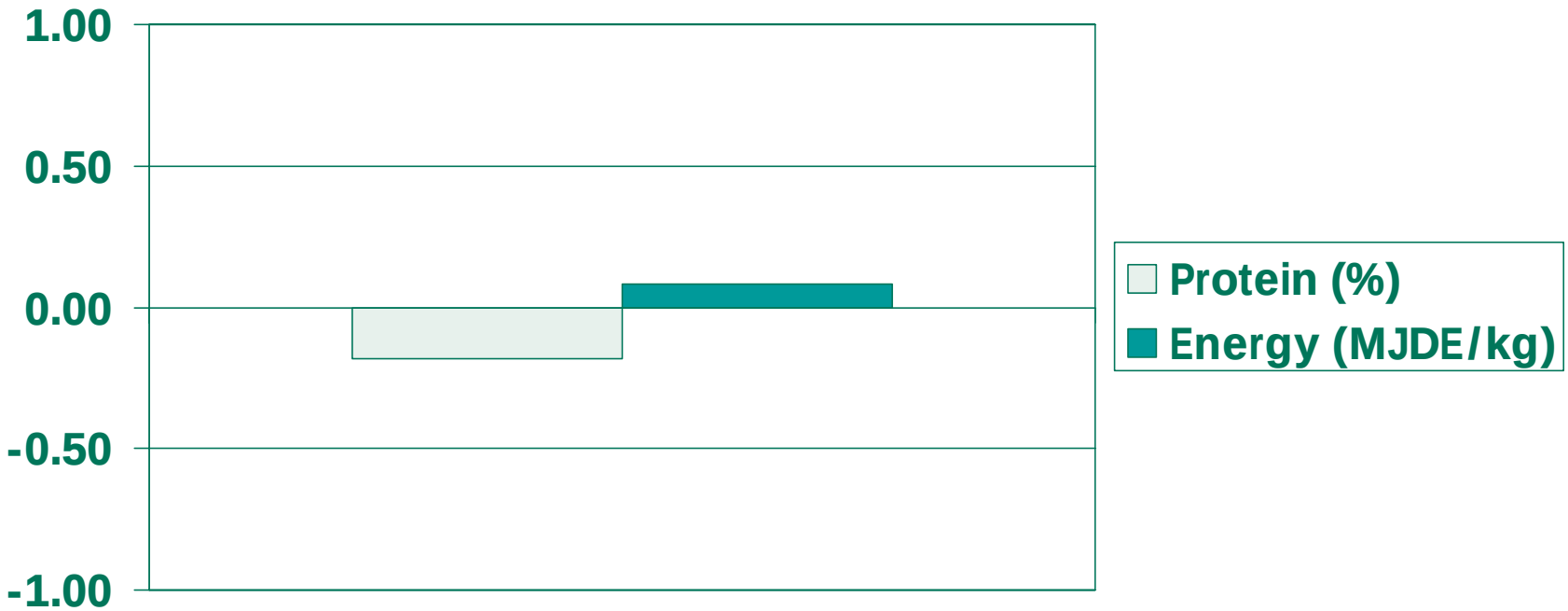
Glucosinolates below 2 μM/g diet DM plus 1mg/kg iodine

(Tripathi and Mishra, 2007; *Etienne *et al*. 2008)

Extracted rape meal reduces wheatfeed and soya



Small effect of extracted rape meal on diet analysis



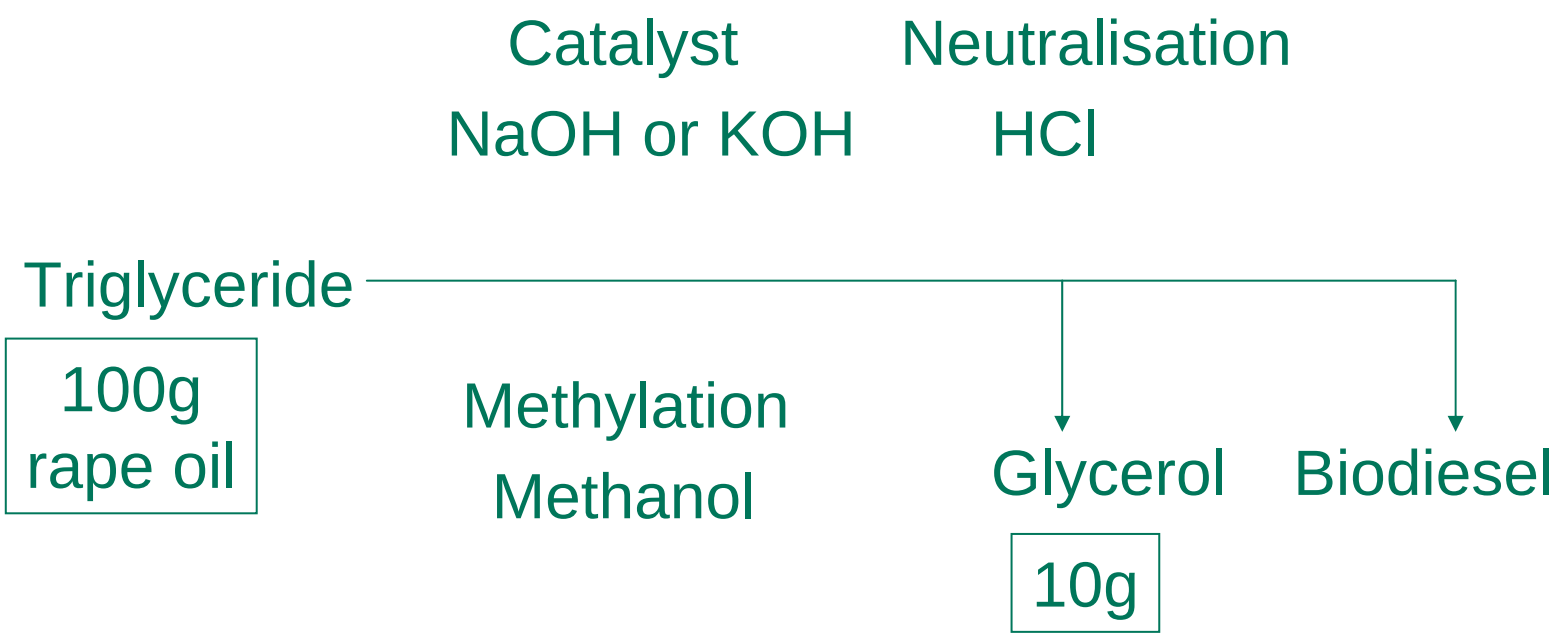
Summary of rape seed meal

- Nutrient analysis
- Effects of glucosinolates
- Effects of inclusion on performance and diet composition

Biofuel co-products

- **Bio ethanol**
  - Distillers dried grains + solubles (DDGS)
    - Maize
    - Wheat
- **Bio diesel**
  - Rape seed meal
  - Glycerol

Production of glycerol



Residues in glycerol

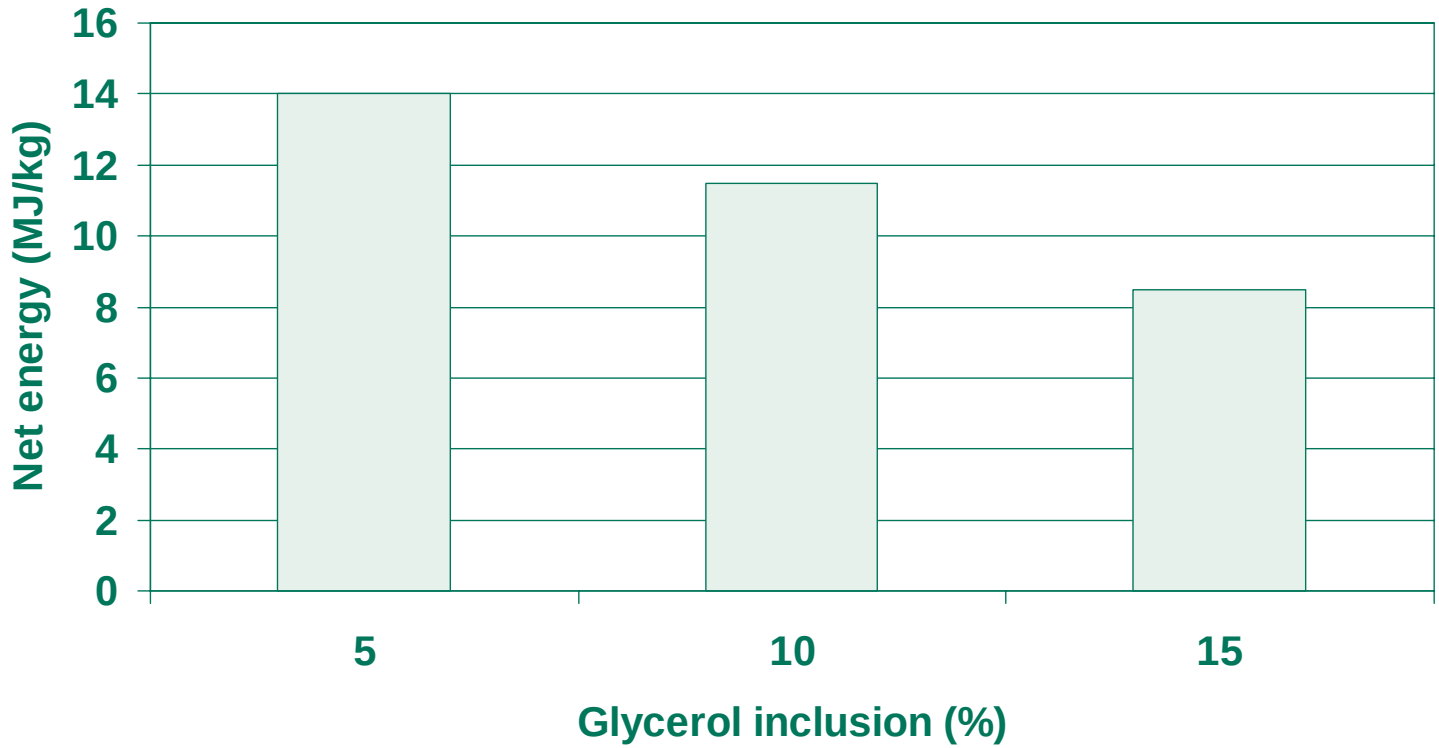
- Methanol
  - FSA recommend a maximum of 0.5%
  - 20 mg methanol / litre plasma threshold in humans
- Salts
  - Sodium or potassium chloride
  - 2% sodium / potassium

Glycerol is an energy source

Energy of glycerol (MJ/kg)	
Gross energy	18.06
Digestible energy	18.06
Net energy	14.00

(Bartelt and Schneider, 2002)

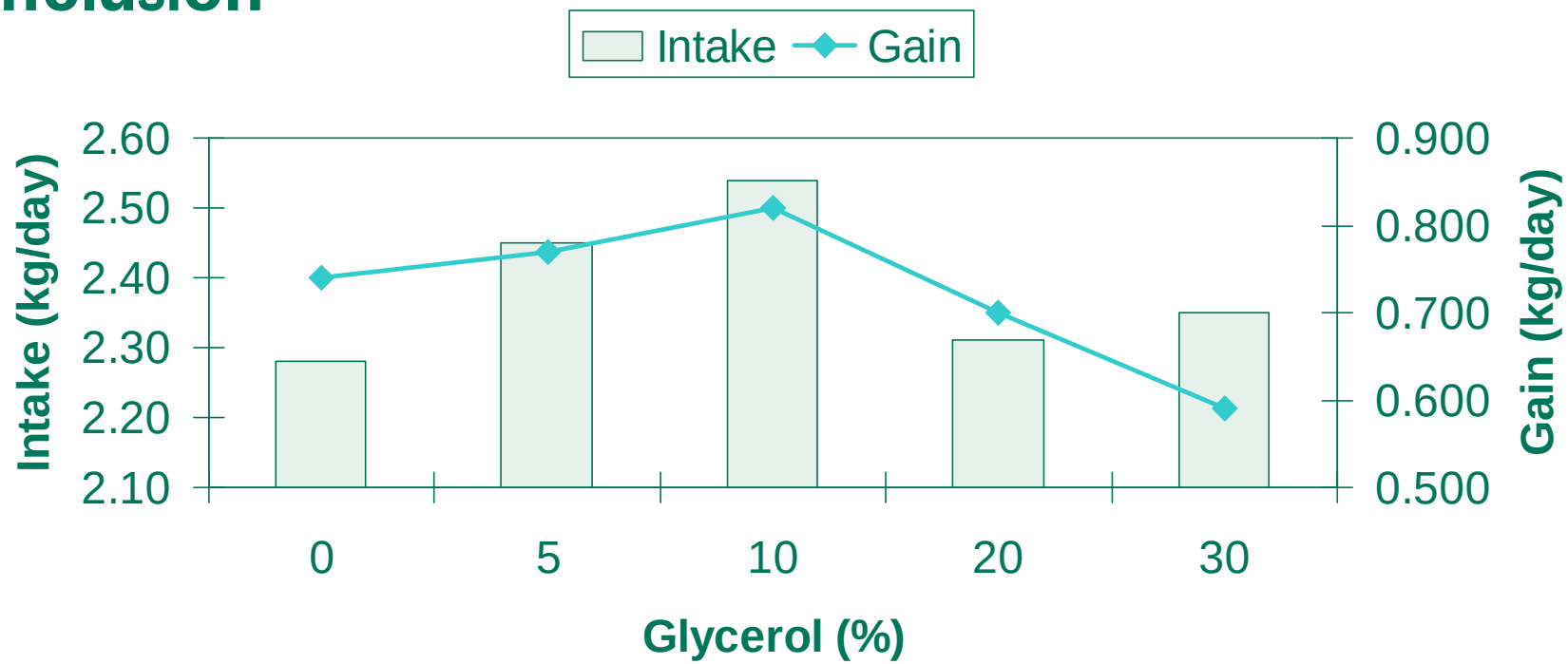
Energy value is dose dependant



(Doppenberg and van der Aar, 2007)

Metabolism of glycerol requires activation by glycerine kinase if saturated excess glycerol accumulates in the plasma and is excreted in the urine .

Glycerol improved gain and intake up to 10% inclusion



(Kijora *et al*., 1993)

Glycerol increases water holding capacity of muscle

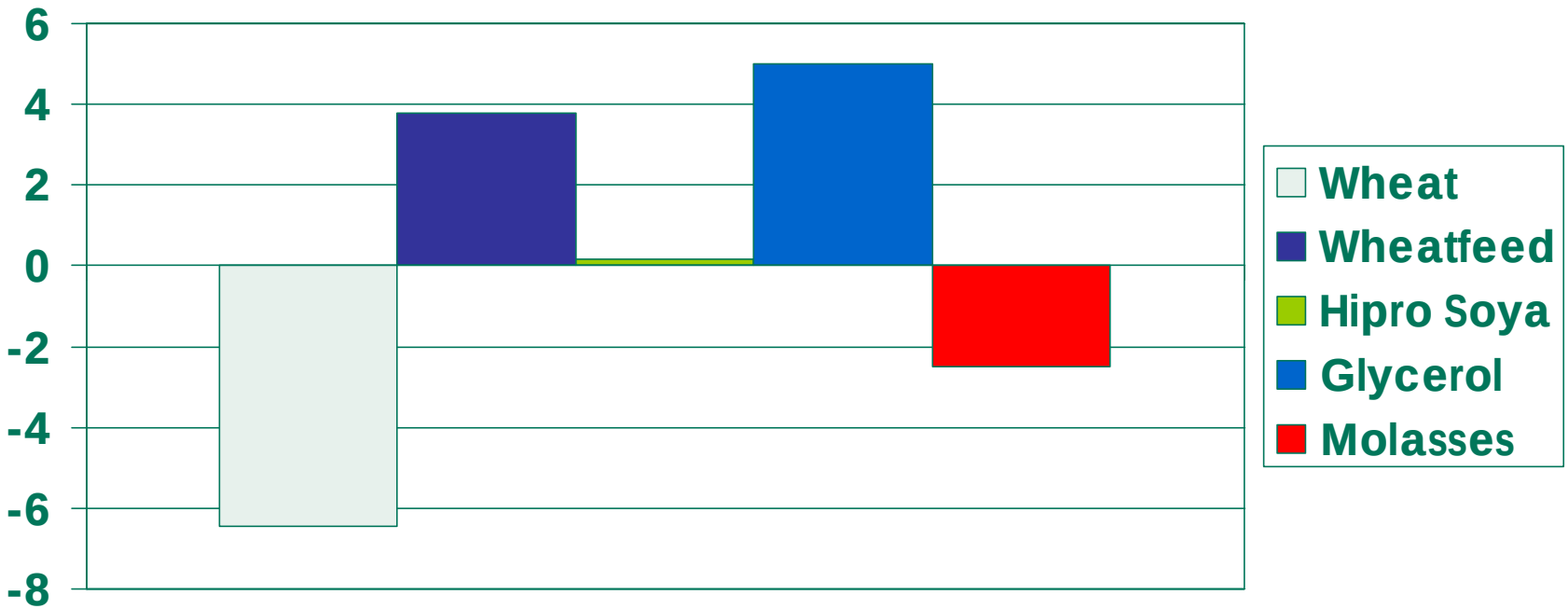
Glycerol (%)		0	5
35 – 102 kg	Drip loss	1.84[a]	1.39[b]
	Cooking loss	29.42[a]	25.58[b]
80 – 110 kg	Cooking yield (%)	100[a]	101.9[b]
[a,b] (P<0.05)			

(Mourot *et al*., 1998 and Cerneau *et al*., 1994)

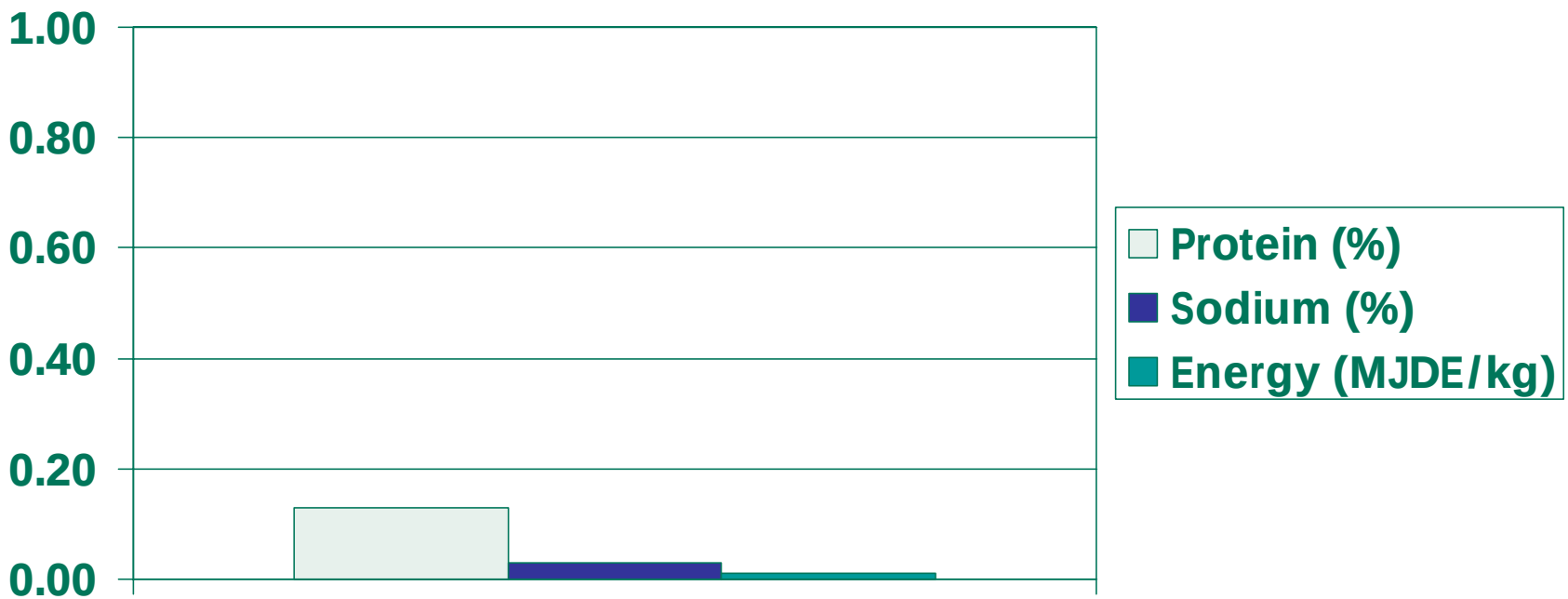
Feed grade glycerol

- Variable quantity of glycerol, impurities and minerals
- Addition of water can reduce viscosity and improve handling
- Improved physical quality of pelleted feed
- Suggested inclusion 5%

Glycerol reduces wheat and molasses



Glycerol has a small effect on diet analysis



Summary of glycerol

- Potential residues
- Energy value
- Effect of inclusion on performance and diet composition

Summary of factors affecting product value

- DDGS
  - Consistency of product analysis
    Digestibility of amino acids
- Rape seed meal
  - Glucosinolate content
  - Variability in analysis (expeller)
- Glycerol
  - Saturation of glycerine kinase
  - Methanol content

(Reuters)