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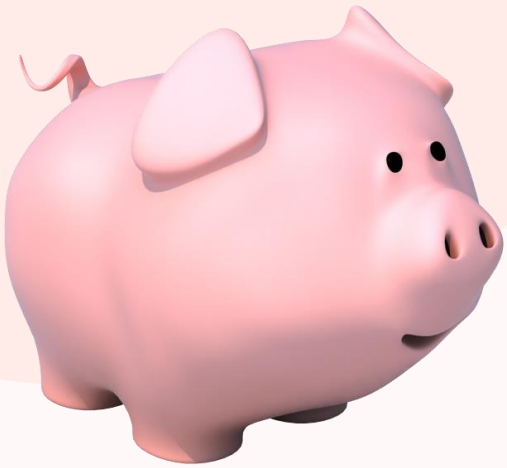

Equations and coefficients

Version 1.3

INRA

Association Française de Zootechnie

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AJINOMOTO ANIMAL NUTRITION

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Credits and acknowledgments

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Introduction

The purpose of this document is to provide users with a full reference of the equations and coefficients used throughout EvaPig® to calculate energy, protein and mineral values.

These equations are used at 4 different places in EvaPig®:

- Ingredient creation based on a reference ingredient
- Diet creation based on a list of ingredients
- Ingredient creation based on chemical composition only
- Diet creation based on chemical composition only

Calculations based on chemical composition only are very similar for ingredients and diets and will be presented in the same chapter.

Units and abbreviations

The equations and coefficients below are expressed using the following units:

- MJ/kg dry matter (DM) for energy values
- % DM for the chemical composition
- % for ratios and digestibilities

The coefficients are only valid when the data are expressed in those units. If you want to use other units, such as kcal/kg for energy or g/kg for chemical values, please convert the coefficients accordingly.

Please note that many equations only work when the input data are expressed on the dry matter basis.

The following table presents the abbreviations used in this manual.

Table 1. List of abbreviations

ADF	Acid detergent fibre
DE	Digestible energy
DEa	Digestible energy for adult pig
DEg	Digestible energy for growing pigs
DM	Dry matter
DP	Digestible phosphorus
Ed	Energy digestibility
Eda	Energy digestibility for adult pigs
Edg	Energy digestibility for growing pigs
EUri	Energy lost from urinary nitrogen
GE	Gross energy

ME	Metabolizable energy
MEa	Metabolizable energy for adult pigs
MEg	Metabolizable energy for growing pigs
MJ	Megajoules
Nd	Faecal nitrogen digestibility
NDF	Neutral detergnt fiber
NE	Net energy
NEa	Net energy for adult pigs
NEg	Net energy for growing pigs
NUri	Nitrogen lost in urine
OMd	*In vivo* organic matter digestibility
OMdg	*In vivo* organic matter digestibility for growing pigs
OMdv	*In vitro* organic matter digestibility
Pd	Phosphorus digestibility
Res	Residue = 100 – Ash – Protein – Fat – Starch – Sugars
ResD	Digestible residue

Validation checks

Several checks are used to ensure that the data are valid and consistent with each other.

- The sum of nutriments in a diet or an ingredient should not be higher than 105% with NDF as the fibrous fraction. When the NDF analysis is absent, it is estimated as 3 x ADF (if present) or 3.5 x crude fibre (if no other fibre analysis is present). These coefficients are on the
- The sum of amino acids should not be higher than 110% of crude protein.

Calculations

EvaPig® uses equations to calculate the nutritional values of new ingredients and diets. These equations were obtained through INRA experiments or derived from literature data.

The main benefit of using equations is that the predicted values are more precise than fixed values. However, this precision depends on many factors, not all of which are known, and users should always exercise caution when using predicted values.

1. Ingredient creation based on a reference ingredient

1.1 General principles

Creating a new ingredient using a reference ingredient is the recommended method. The calculations combine the values of the reference ingredient with coefficients that are applied to the differences in chemical composition between the new ingredient and the reference ingredient. Some equations have generic coefficients while others have ingredient-specific ones.

The formula is of the general form:

$$Y_{New} = Y_{Ref} + a \times (X_{New} - X_{Ref}) + b \times (Z_{New} - Z_{Ref}) + \ldots$$

where Y is the predicted value and X, Z etc. are the predictors. "New" refers to the new ingredient and "Ref" refers to the reference ingredient.

1.2 Energy values

1.2.1 Calculation outline

The calculation of energy values involves the following steps:

- GE = f(protein, fat, ash)
- Ed = f(fibre)
- DE = GE x Ed
- DEa=f(DEg, Edg, ash)
- ME/DE = f(protein, DE)
- ME = DE x ME/DE
- NE/ME = f(protein, fat, starch, ME)
- NE = ME x NE/ME

1.2.2 Gross energy

Gross energy (GE) is calculated from the reference ingredient using the following coefficients:

$$GE_{New} = GE_{Ref} + 0.0616 \times (Protein_{New} - Protein_{Ref}) + 0.2192 \times (Fat_{New} - Fat_{Ref}) - 0.1866 \times (Ash_{New} - Ash_{Ref})$$

1.2.3 Energy digestibility (Ed) and digestible energy (DE)

Energy digestibility (Ed) for growing pigs is calculated from the reference ingredient with ingredient-specific equations that use fibre as a predictor.

The fibre value can be either crude fibre, NDF or ADF, with different values for the coefficient.

$$Ed_{New} = Ed_{Ref} + a \times (Fibre_{New} - Fibre_{Ref})$$

where **a** is the ingredient-specific coefficient for either crude fibre, NDF and ADF.

The coefficients for fibre are provided in Table 5 at the end of this document.

However, as the user may use new values for crude fibre, NDF and ADF, the final value is calculated as the average of the calculated values for the available (new) fibre data. For instance, if the user provides new values for both NDF and ADF, the calculation will be:

$$Ed_{NewNDF} = Ed_{Ref} + a_{NDF} \times (NDF_{New} - NDF_{Ref})$$

$$Ed_{NewADF} = Ed_{Ref} + a_{ADF} \times (ADF_{New} - ADF_{Ref})$$

$$Ed_{New} = (Ed_{NewNDF} + Ed_{NewADF}) / 2$$

a_{NDF} and a_{ADF} are the coefficients for the NDF and ADF-based equations respectively.

The energy bonus is added to the energy digestibility coefficient:

$$Ed_{New} = Ed_{New} \times (100 + Bonus) / 100$$

Digestible energy is calculated as follows:

$$DE_{New} = Ed_{New} \times GE_{New} / 100$$

1.2.4 Metabolizable / digestible energy ratio

The ME/DE ratio for growing and adult pigs is calculated using a generic coefficient for protein.

$$ME/DE_{New} = ME/DE_{Ref} - 1.98 \times (Protein_{New} - Protein_{Ref}) / DE_{New}$$

The reference ME/DE ratios are provided in Table 6 at the end of this document.

1.2.5 Net energy / metabolizable energy

The NE/ME ratio for growing and adult pigs is calculated using generic coefficients:

$$NE/ME_{New} = NE/ME_{Ref} + ((5.5 \times (Fat_{New} - FAt_{Ref}) + 1.5 \times (Starch_{New} - Starch_{Ref}) - 2.8 \times (Protein_{New} - Protein_{Ref})) / ME_{New}$$

The reference NE/ME ratios are provided in Table 6 at the end of this document.

1.2.6 Digestible energy for adult pigs

The digestible energy for adult pigs (DEa) is calculated from the digestible energy for growing pigs (DEg) using ingredient-specific coefficients.

$$DEa_{New} = DEg_{New} + a_{Ref} \times (1 - Ash_{New} / 100) \times (1 - b_{Ref} \times Edg_{New} / 100)$$

If no ash value is provided for the new ingredient, the ash value of the reference is used instead.

$$DEa_{New} = DEg_{New} + a_{Ref} \times (1 - Ash_{Ref} / 100) \times (1 - b_{Ref} \times Edg_{New} / 100)$$

The a and b coefficients for the equations above are provided in Table 6 at the end of this document.

1.3 Faecal nitrogen digestibility

Faecal nitrogen digestibility (Nd) for a new ingredient is calculated from the reference ingredient using generic coefficients for protein and fibre. Those coefficients differ for growing and adult pigs.

$$Nd_{New} = Nd_{Ref} + a \times (Protein_{New} - Protein_{Ref}) + b \times (Fibre_{New} - Fibre_{Ref})$$

The a and b coefficients are shown below in Table 1.

Table 2. Fibre and protein coefficients for the prediction of nitrogen digestibility

Type of pig	Type of fibre	a (protein)	b (fibre)
Growing	CF	0.69	-1.21
	NDF	0.79	-0.69
	ADF	0.70	-1.16
Adult	CF	0.77	-0.87
	NDF	0.86	-0.44
	ADF	0.78	-0.83

2. Diets created from a list of ingredients

2.1 General principles

Diets are usually created in EvaPig® using a list of ingredients. The chemical and nutritional values are calculated as the weighed contributions of the ingredients, taking into account their incorporation rates and dry matter values.

For that reason, when a nutrient is missing from an ingredient, it will not be part of the diet calculations. For instance, if an ingredient does not have a net energy value attached, net energy will not be calculated for any diet including this ingredient.

2.2 Digestible phosphorus

The digestibility of the phosphorus provided by the ingredients may be reduced by processing, which decreases the activity of endogenous phytase, and it may be increased by addition of exogenous phytase. To calculate the digestible phosphorus content of a diet, it is necessary to know:

- The phosphorus content of the individual ingredient
- The phosphorus digestibility of those ingredients, both in mash (unprocessed) and pellet (processed) form
- The physical form of the diet (mash or pellet)
- The amount and concentration of exogenous phytase added to the diet that will release part of the phytic phosphorus
- The quality of the phytase, expressed as the amount of digestible phosphorus released per 500 IU of phytase.

When no phytase is added, the calculation is straightforward, and consists in summing the contributions of each ingredient, taking into account the incorporation rate and whether or not the diet is processed: for an unprocessed diet, the values will be those of the mash ingredients while for a processed diet, the values will be those of the pelleted ingredients.

When phytase is added, the calculation adds its contribution to phosphorus release. The relationship between the level of phytase and the amount of released phosphorus is curvilinear:

Equation #1

$$\text{Released P} = 1.026 \times (1-e^{(-0.00263 \times \text{Phytase units} \times c)})$$

For a known quantity of released P, the number of phytase units necessary can be calculated as follows:

Equation #2

$$\text{Phytase units} = -\text{Ln}(1-P_{released}/1.026)/(-0.00263 \times c)$$

P is expressed in g and the phytase units in IU.

The coefficient c depends on the activity of the phytase used, expressed in g of released P per 500 IU of phytase.

Table 3. Coefficients for the prediction of phytase units

Phytase activity	c
0.60	0.668
0.65	0.763
0.70	0.872
0.75	0.999
0.80	1.151
0.85	1.340
0.90	1.595

The calculation of the digestible phosphorus in the diet goes as follows:

First, digestible P is calculated using the values of the ingredients. This calculation will use the mash or pellet ingredient values depending on the diet form.

If the diet is in pellet form, the ingredients do not contribute to phosphorus release (endogenous phytase is deactivated) and release of phytic P is entirely due to the

added phytase. The released P is calculated using Equation #1 and added to the digestible P.

If the diet is in mash form, the ingredients contribute to phosphorus release, so the released P is due to endogenous and exogenous sources of phytase.

1. The difference between the digestible phosphorus values for mashed and pelleted ingredients is used in Equation #2 to calculate the amount of endogenous phytase:

$$Phytase_{Endo} = f(dP_{Mash} - dP_{Pellet})$$ where *f* is Equation #2

2. The total amount of phytase is calculated by adding the (known) quantity of exogenous phytase to the quantity of endogenous phytase calculated previously:

$$Phytase_{Total} = Phytase_{Exo} + Phytase_{Endo}$$

3. This value is used in Equation #1 to calculate the total amount of phosphorus released by both endogenous and exogenous phytase:

$$P_{ReleasedTotal} = f(Phytase_{Total})$$ where *f* is Equation #1

4. The amount of P released by exogenous phytase is calculated as the difference between the total amount of released P calculated in the previous step minus the amount of P released by endogenous phytase:

$$P_{ReleasedExo} = P_{ReleasedTotal} - P_{ReleasedEndo}$$

5. The total digestible phosphorus is then calculated as the sum of digestible phosphorus from the mashed ingredient and the phosphorus released by exogenous phytase:

$$dP_{Total} = dP_{Mash} + P_{ReleasedExo}$$

3. Ingredients and diets created using chemical composition

New ingredients and diets can be created using only their chemical composition. In this case, all the calculations are based on generic equations.

This method of calculation is less precise and does not take into account ingredient-specific effects such as anti-nutritional factors or the structure of cell walls. Therefore, it should be used only when it is not possible to base the calculations on known ingredient values.

3.1 Energy values

3.1.1 Calculation outline

The calculation of energy values involves the following steps. Some predictors are optional.

- GE = f(protein, fat, ash, fibre, sugars, starch); GE value can also be provided and it will be used instead of GE calculated from chemical characteristics.
- Ingredient Ed = f(fibre); ash should not be used
- Diet Ed = f(fibre, ash, in vitro digestible organic matter)
- DE = GE x Ed

- DEa=f(DEg, Edg, ash, protein)
- Energy lost from urine = f(protein)
- Energy lost as methane = f(ash, protein, fat, starch, sugars)
- ME = f(DE, Energy urine, Energy methane)
- NE = f(DE, protein, fat, starch, fibre)

Unlike the calculations used for ingredients, these equations use only generic coefficients.

3.1.2 Gross energy

EvaPig® uses several equations to predict gross energy. The equation used depends on the available chemical values.

Equations requiring fibre and sugars

GE = 17.56 + 0.0551 x Protein + 0.2148 x Fat + 0.0259 x Crude fibre – 0.1774 x Ash– 0.0114 x Sugars

GE = 17.56 + 0.0545 x Protein + 0.2150 x Fat + 0.0216 x ADF – 0.1769 x Ash– 0.0115 x Sugars

GE = 17.41 + 0.0579 x Protein + 0.2163 x Fat – 0.1812 x Ash + 0.0148 x NDF – 0.0072 x Sugars

When more than one type of fibre is available, the final GE value is the average of all the predicted values.

Equations requiring fibre but not sugars

GE = 17.57 + 0.0535 x Protein + 0.2168 x Fat + 0.0284 x Crude fibre – 0.1861 x Ash

GE = 17.58 + 0.0529 x Protein + 0.2171 x Fat + 0.0238 x ADF – 0.1858 x Ash

GE = 17.40 + 0.0573 x Protein + 0.2176 x Fat + 0.0161 x NDF – 0.1873 x Ash

When more than one type of fibre is available, the final GE value is the average of all the predicted values.

Equation without fibre

GE = 18.88 + 0.0424 x Protein + 0.2025 x Fat – 0.2037 x Ash – 0.0142 x Starch – 0.0238 x Sugars

Equation without fibre and sugars

GE = 18.47 + 0.0414 x Protein + 0.2108 x Fat – 0.1964 x Ash – 0.0092 x Starch

Equation without fibre and starch

```
GE = 17.61 + 0.0505 x Protein + 0.2153 x Fat – 0.1506 x
Ash – 0.0148 x Sugars
```

Equation without fibre, sugars and starch

```
GE = 17.64 + 0.0478 x Protein + 0.2180 x Fat – 0.1588 x
Ash
```

3.1.3 Energy digestibility

The prediction of energy digestibility in growing pigs requires at least a fibre value.

For ingredients and diets

```
Edg = 90.1 – 1.57 x Crude fibre
Edg = 98.3 – 0.90 x NDF
Edg = 90.8 – 1.43 x ADF
```

When more than one type of fibre is available, the final Ed value is the average of all the predicted values.

For diets only

For diets created using chemical composition, it is also possible to use ash and *in vitro* organic matter digestibility (OMdv, %); Noblet and Jaguelin-Peyraud, 2007) as predictors.

Equations with fibre and ash

```
Edg = 98.0 – 1.60 x Ash – 1.26 x Crude fibre
Edg = 102.6 – 1.06 x Ash – 0.79 x NDF
Edg = 97.9 – 1.46 x Ash – 1.17 x ADF
```

Equations with OMdv (%), fibre and ash

```
Edg = 35.5 + 0.64 x OMdv – 0.68 x Crude fibre – 0.68 x
Ash
Edg = 41.0 + 0.58 x OMdv – 0.74 x ADF – 0.64 x Ash
```

Equations with OMdv and fibre

```
Edg = 30.1 + 0.66 x OMdv – 0.77 x Crude fibre
Edg = 36.2 + 0.60 x OMdv – 0.82 x ADF
```

Equations with OMdv only

```
Edg = 0.976 x OMdv
```

Adult pigs

Digestible energy for adult pigs is calculated from that of the growing pigs corrected for *in vivo* organic matter digestibility (OMd, %):

```
OMd = (7.45 + 0.949 x Edg – 0.04 x Protein)
DEa = DEg + 4.2 x (1 – Ash / 100) x (1 – OMd / 100)
```

3.1.4 Metabolizable energy

Metabolizable energy is calculated from the digestible energy using estimates for the energy lost in methane gas and in urine. The calculation involves the following steps.

Nitrogen lost in urine (40% of N in feed; % of feed DM)

```
NUri = 0.4 x Protein / 6.25
```

Energy lost from urinary nitrogen

```
Growing pigs:    EUri = 0.19 + 0.31 x NUri
Adult pigs:      EUri = 0.22 + 0.31 x NUri
```

Residue

```
Res = 100 – Ash – Protein – Fat – Starch – Sugars
```

When the sugars content is missing, a default value of 2% DM is used.

Digestible residue

```
Growing pigs:    ResD = 0.5 x Res
Adult pigs:      ResD = 0.6 x Res
```

Energy lost as methane

```
Growing pigs:    ECH4 = 0.67 x ResD / 100
Adult pigs:      ECH4 = 1.34 x ResD / 100
```

Metabolizable energy

```
Growing pigs:    MEg = DEg – EUri – ECH4
Adult pigs:      MEa = DEa – EUri – ECH4
```

3.1.5 Net energy

Net energy is calculated using digestible energy, protein, fat, starch and a fibre value. The equation is the same for growing pigs and adult pigs but DE values differ between both stages (DEg and DEa).

```
NE = 0.703 x DE – 0.0404 x Protein + 0.0662 x Fat +
0.0197 x Starch – 0.0409 x Crude fibre

NE = 0.703 x DE – 0.0410 x Protein + 0.0664 x Fat +
0.0197 x Starch – 0.0134 x NDF

NE = 0.700 x DE – 0.0382 x Protein + 0.0674 x Fat +
0.0202 x Starch – 0.0365 x ADF
```

When more than one type of fibre is available, the final NE value is the average of all the predicted values.

3.2 Faecal nitrogen digestibility

Faecal nitrogen digestibility (Nd) for a new ingredient or diet is calculated using generic coefficients for protein and fibre that differ for growing and adult pigs.

Growing pigs

```
Nd = 76.8 + 0.69 x Protein – 1.22 x Crude fibre
Nd = 81.3 + 0.79 x Protein – 0.69 x NDF
Nd = 77.4 + 0.70 x Protein – 1.16 x ADF
```

Adult pigs

```
Nd = 77.9 + 0.77 x Protein – 0.87 x Crude fibre
Nd = 79.9 + 0.86 x Protein – 0.44 x NDF
Nd = 78.3 + 0.78 x Protein – 0.83 x ADF
```

When more than one type of fibre is available, the final Nd value is the average of all the predicted values.

3.3 Default values for standardised ileal amino acid digestibilities

When an ingredient is created from the chemical composition, the following default values are given for standardised ileal amino acid digestibilities.

Table 4. Default values for standardised ileal amino acid digestibility

Amino acid	Digestibility
Lys	77.0
Thr	76.0
Met	84.6
Cys	73.3
Met+Cys	78.8
Trp	77.2
Ile	80.7
Val	77.7
Leu	83.3
Phe	84.2
Tyr	85.5
Phe+Tyr	84.7
His	84.1
Arg	88.7
Ala	77.3
Asp	79.1
Glu	86.1
Gly	71.8
Ser	80.7
Pro	78.7

3.4 Default values for phosphorus digestibility

When an ingredient is created from the chemical composition, the default value for phosphorus digestibility (mash and pellet) is 20%.

Ingredient-specific coefficients and ratios

The tables below present the coefficients and ratios used for the prediction of the energy values of ingredients based on reference ingredients.

Table 5. Fibre coefficients for the prediction of energy digestibility (dEg; % change of dEg per 1 % change in fibre content)

Name	Crude fibre	NDF	ADF
Alfalfa protein concentrate	-1.57	-0.79	-1.43
Alfalfa, dehydrated, protein 17-18% DM	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 18-19% DM	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 22-25% DM	-1.57	-0.90	-1.43
Alfalfa, dehydrated, proteins < 16% DM	-1.57	-0.90	-1.43
Barley	-2.53	-0.90	-1.72
Barley brewers' grains, dehydrated	-2.53	-0.90	-1.72
Barley rootlets, dehydrated	-2.53	-0.90	-1.72
Beet pulp, dehydrated	-1.57	-0.90	-1.43
Beet pulp, dehydrated, molasses added	-1.57	-0.90	-1.43
Beet pulp, pressed	-1.57	-0.90	-1.43
Blood meal	0.00	0.00	0.00
Carob pod meal	-1.57	-0.88	-1.43
Cassava, starch 67%	-1.66	-0.90	-1.43
Cassava, starch 72%	-1.66	-0.90	-1.43
Chickpea	-1.57	-0.90	-1.43
Citrus pulp	-1.57	-0.90	-1.43
Cocoa hulls	-1.57	-0.90	-1.43
Cocoa meal, full extraction	-1.57	-0.90	-1.43
Copra meal	-1.57	-0.90	-1.43
Corn distillers' grains	-3.93	-0.90	-3.11
Corn distillers, dehydrated	-3.93	-0.90	-3.11
Corn gluten feed	-3.93	-0.90	-3.11
Corn gluten meal	-3.93	-0.90	-3.11
Cottonseed	-1.57	-0.90	-1.43
Cottonseed meal, crude fibre 14-20%	-1.57	-0.90	-1.43
Cottonseed meal, crude fibre 7-14%	-1.57	-0.90	-1.43
DL-Methionine	0.00	0.00	0.00
Faba bean, coloured flowers	-1.57	-0.90	-1.43
Faba bean, white flowers	-1.57	-0.90	-1.43
Feather meal	0.00	0.00	0.00
Fish meal, protein 62%	0.00	0.00	0.00
Fish meal, protein 65%	0.00	0.00	0.00
Fish meal, protein 70%	0.00	0.00	0.00
Fish oil	0.00	0.00	0.00
Fish protein concentrate, defatted	0.00	0.00	0.00
Fish protein concentrate, fat	0.00	0.00	0.00
Grape seeds	-1.57	-0.90	-1.43
Grapeseed oil meal	-1.57	-0.90	-1.43
Grass, dehydrated	-1.57	-0.90	-1.43
Groundnut meal	-1.57	-0.90	-1.43
Groundnut meal, detoxified, crude fibre < 9%	-1.57	-0.90	-1.43
Hominy feed	-3.93	-0.90	-3.11
Lard	0.00	0.00	0.00
Linseed meal, expeller extraction	-1.57	-0.90	-1.43

Name	Crude fibre	NDF	ADF
Linseed meal, solvent extraction	-1.57	-0.90	-1.43
Linseed, extruded	-1.57	-0.90	-1.43
Liquid potato feed	-1.57	-0.90	-1.43
L-Lysine HCl	0.00	0.00	0.00
L-Threonine	0.00	0.00	0.00
L-Tryptophan	0.00	0.00	0.00
Lupin, blue	-1.57	-0.90	-1.43
Lupin, white	-1.57	-0.90	-1.43
L-Valine	0.00	0.00	0.00
Maize	-3.83	-0.90	-3.11
Maize bran	-1.57	-0.90	-1.43
Maize feed flour	-3.93	-0.90	-3.11
Maize germ meal, deoiled	-1.57	-0.90	-1.43
Maize germ meal, non deoiled	-1.57	-0.90	-1.43
Meat and bone meal, fat < 7.5%	0.00	0.00	0.00
Meat and bone meal, fat > 7.5%	0.00	0.00	0.00
Methionine Hydroxy Analogue MHA, 80% efficiency	0.00	0.00	0.00
Milk powder, skimmed	0.00	0.00	0.00
Milk powder, unskimmed	0.00	0.00	0.00
Molasses, beet	-1.57	-0.90	-1.43
Molasses, sugarcane	-1.57	-0.90	-1.43
Oats	-2.13	-0.90	-1.43
Oats, decorticated	-2.13	-0.90	-1.43
Palm kernel meal	-1.57	-0.90	-1.43
Pea	-1.57	-0.90	-1.43
Pea bran, starch industry by-product	-1.57	-0.90	-1.43
Pea proteins, starch industry by-product	-1.57	-0.90	-1.43
Pea pulp, starch industry by-product	-1.57	-0.90	-1.43
Pea solubles, starch industry by-product	-1.57	-0.90	-1.43
Potato pulp, dehydrated	-1.57	-0.90	-1.43
Potato tuber, dehydrated	-1.57	-0.90	-1.43
Potato, protein concentrate	-1.57	-0.79	-1.43
Poultry fat	0.00	0.00	0.00
Rapeseed	-1.57	-0.90	-1.43
Rapeseed meal	-1.57	-1.21	-1.34
Rice bran, defatted	-1.57	-0.90	-1.43
Rice bran, fat	-1.57	-0.90	-1.43
Rice, broken	-1.57	-0.90	-1.43
Rice, brown	-1.57	-0.90	-1.43
Rye	-1.57	-0.90	-1.43
Sesame meal	-1.57	-0.90	-1.43
Sorghum	-1.57	-0.90	-1.43
Soybean hulls	-1.01	-0.71	-1.43
Soybean meal, 46	-1.01	-0.71	-1.43
Soybean meal, 48	-1.01	-0.71	-1.43
Soybean meal, 50	-1.01	-0.71	-1.43
Soybean, full-fat, extruded	-1.57	-0.90	-1.43
Soybean, full-fat, toasted	-1.57	-0.90	-1.43
Starch, maize	-1.57	-0.90	-1.43
Sunflower meal, decorticated	-1.27	-1.04	-1.32
Sunflower meal, undercorticated	-1.27	-1.04	-1.32
Sunflower seed	-1.57	-0.90	-1.43
Sweet potato, dehydrated	-1.57	-0.90	-1.43
Tallow	0.00	0.00	0.00
Triticale	-3.33	-0.90	-1.43
Vegetable oil	0.00	0.00	0.00

Name	Crude fibre	NDF	ADF
Vinasse, different origins	-1.57	-0.90	-1.43
Vinasse, from the production of glutamic acid	-1.57	-0.90	-1.43
Vinasse, from yeast production	-1.57	-0.90	-1.43
Wheat bran	-3.90	-0.92	-1.43
Wheat bran, durum	-3.90	-0.92	-1.43
Wheat distillers' grains, dark colour, L < 50	-3.90	-0.92	-1.43
Wheat distillers' grains, light colour, L > 50	-3.90	-0.92	-1.43
Wheat distillers' grains, starch < 7%	-3.90	-0.92	-1.43
Wheat distillers' grains, starch > 7%	-3.90	-0.92	-1.43
Wheat feed flour	-3.90	-0.92	-1.43
Wheat gluten feed, starch 25%	-3.90	-0.92	-1.43
Wheat gluten feed, starch 28%	-3.90	-0.92	-1.43
Wheat middlings	-3.90	-0.92	-1.43
Wheat middlings, durum	-3.90	-0.92	-1.43
Wheat shorts	-3.90	-0.92	-1.43
Wheat straw	-1.57	-0.90	-1.43
Wheat, durum	-3.94	-0.90	-1.43
Wheat, soft	-3.94	-0.90	-1.43
Whey, acid, skimmed, dehydrated	0.00	0.00	0.00
Whey, sweet, dehydrated, skimmed	0.00	0.00	0.00
Yeast, brewers', dehydrated	-1.57	-0.90	-1.43

Table 6. Energy ratios (%) and coefficients for converting DE in growing pig to DE in adult pig

	Growing		Adult		DEa/DEg	DEg➔ DEa	
Name	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Alfalfa protein concentrate	91.8	63.7	90.9	64.9	102.0	3.01	1.035
Alfalfa, dehydrated, protein 17-18% DM	92.8	54.5	90.2	56.3	118.4	3.01	1.102
Alfalfa, dehydrated, protein 18-19% DM	92.8	55.2	90.3	56.9	117.4	3.01	1.097
Alfalfa, dehydrated, protein 22-25% DM	92.8	58.7	90.7	59.9	112.8	3.01	1.070
Alfalfa, dehydrated, proteins < 16% DM	92.7	53.0	90.0	55.1	120.6	3.01	1.113
Barley	96.8	76.7	96.1	76.8	102.7	2.51	1.036
Barley brewers' grains, dehydrated	92.3	67.9	91.0	67.5	109.9	2.51	1.067
Barley rootlets, dehydrated	93.0	64.6	91.6	65.1	107.7	2.51	1.057
Beet pulp, dehydrated	94.3	60.2	91.2	63.4	112.9	6.99	1.049
Beet pulp, dehydrated, molasses added	94.4	60.5	91.4	63.4	112.3	6.99	1.048
Beet pulp, pressed	94.2	59.7	90.9	63.0	113.0	6.99	1.049
Blood meal	89.4	56.2	89.3	56.6	100.0	0.00	1.000
Carob pod meal	96.7	70.5	95.9	69.3	109.5	2.01	1.088
Cassava, starch 67%	98.3	81.5	97.8	80.9	102.2	3.01	1.028
Cassava, starch 72%	98.4	80.5	98.0	80.4	101.3	3.01	1.001
Chickpea	96.0	75.1	95.5	75.1	103.7	5.98	1.024
Citrus pulp	95.6	64.6	93.2	66.9	111.3	6.99	1.047
Cocoa hulls	93.0	68.6	91.0	63.4	136.7	2.01	1.201
Cocoa meal, full extraction	92.3	61.1	90.6	62.0	108.7	3.01	1.054
Copra meal	93.3	68.0	91.8	67.9	110.9	3.01	1.066
Corn distillers' grains	93.9	59.0	92.2	59.7	108.5	7.00	1.030
Corn distillers, dehydrated	93.6	66.6	91.9	67.7	115.9	6.99	1.047
Corn gluten feed	94.3	67.0	92.5	68.1	116.5	6.99	1.051
Corn gluten meal	92.2	64.3	91.9	65.2	102.0	6.99	0.996
Cottonseed	95.0	71.1	93.6	70.8	107.2	3.01	1.025
Cottonseed meal, crude fibre 14-20%	91.3	57.9	89.9	59.3	106.5	3.01	1.036
Cottonseed meal, crude fibre 7-14%	90.8	60.1	90.0	61.0	104.8	3.01	1.020
DL-Methionine	95.0	77.1	94.8	77.1	100.0	0.00	1.000
Faba bean, coloured flowers	94.6	71.0	94.0	70.9	102.8	3.01	1.025

	Growing		Adult		DEa/DEg	DEg➔ DEa	
Name	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Faba bean, white flowers	94.4	70.4	93.8	70.4	102.2	3.01	1.021
Feather meal	90.0	60.6	89.9	60.4	100.0	0.00	1.000
Fish meal, protein 62%	90.5	65.0	90.3	64.8	100.0	0.00	1.000
Fish meal, protein 65%	90.5	64.9	90.3	64.6	100.0	0.00	1.000
Fish meal, protein 70%	90.4	64.5	90.3	64.2	100.0	0.00	1.000
Fish oil	99.4	89.8	99.4	89.8	100.0	0.00	1.000
Fish protein concentrate, defatted	89.6	60.9	89.4	60.7	100.0	0.00	1.000
Fish protein concentrate, fat	91.9	69.4	91.8	69.1	100.0	0.00	1.000
Grape seeds	94.5	66.2	91.9	64.7	112.8	2.01	1.125
Grapeseed oil meal	92.2	45.5	89.0	46.7	119.5	2.01	1.171
Grass, dehydrated	92.7	58.6	90.8	59.1	122.1	3.01	1.114
Groundnut meal	90.4	58.7	89.7	59.3	103.7	3.01	1.012
Groundnut meal, detoxified, crude fibre < 9%	91.2	61.3	90.4	62.1	102.7	3.01	1.009
Hominy feed	96.1	75.5	94.9	75.1	110.7	6.99	1.041
Lard	99.4	89.8	99.4	89.8	100.0	0.00	1.000
Linseed meal, expeller extraction	92.6	65.0	91.1	66.3	104.2	3.01	1.026
Linseed meal, solvent extraction	91.8	61.5	90.2	63.1	104.3	3.01	1.026
Linseed, extruded	96.4	81.4	95.7	81.0	102.5	3.01	1.008
Liquid potato feed	96.0	73.2	94.7	74.3	102.4	4.02	1.008
L-Lysine HCl	90.9	77.9	90.8	77.9	100.0	0.00	1.000
L-Threonine	91.6	77.7	91.5	77.8	100.0	0.00	1.000
L-Tryptophan	94.0	77.3	93.9	77.3	100.0	0.00	1.000
Lupin, blue	92.6	62.2	91.0	63.9	110.4	7.99	1.026
Lupin, white	92.9	64.4	91.6	65.7	105.9	5.98	1.019
L-Valine	94.1	77.3	94.0	77.3	100.0	0.00	1.000
Maize	97.6	80.1	97.1	79.6	104.0	6.99	1.030
Maize bran	96.0	75.8	94.5	72.3	138.4	6.99	1.104
Maize feed flour	97.0	77.9	96.0	76.9	111.7	6.99	1.045
Maize germ meal, deoiled	93.4	63.9	91.6	65.7	104.8	3.01	1.036
Maize germ meal, non deoiled	96.2	76.8	95.2	77.0	104.0	3.01	1.036
Meat and bone meal, fat < 7.5%	88.3	63.8	88.1	62.6	100.0	0.00	1.000
Meat and bone meal, fat > 7.5%	89.7	68.9	89.5	67.9	100.0	0.00	1.000
Methionine Hydroxy Analogue MHA, 80%	95.0	77.1	94.8	77.1	100.0	0.00	1.000
Milk powder, skimmed	94.1	73.3	93.9	73.1	100.0	0.00	1.028
Milk powder, unskimmed	96.5	78.9	96.4	79.2	100.0	0.00	1.011
Molasses, beet	97.2	68.5	97.0	68.6	103.0	3.01	1.000
Molasses, sugarcane	98.1	69.9	97.8	70.4	103.1	3.01	1.000
Oats	96.2	74.9	95.2	74.5	106.3	2.51	1.057
Oats, decorticated	96.8	76.5	96.1	76.8	102.1	2.51	1.032
Palm kernel meal	92.6	68.6	90.6	68.0	118.0	3.01	1.105
Pea	95.3	73.2	94.6	73.1	103.6	5.98	1.023
Pea bran, starch industry by-product	94.3	58.8	91.1	60.3	107.8	6.00	1.068
Pea proteins, starch industry by-product	90.3	56.5	90.0	56.7	100.5	6.00	0.999
Pea pulp, starch industry by-product	96.5	72.3	95.0	72.8	103.0	6.00	1.021
Pea solubles, starch industry by-product	93.6	63.7	93.3	63.8	101.9	6.00	1.013
Potato pulp, dehydrated	96.6	72.1	95.0	72.2	107.8	4.02	1.039
Potato tuber, dehydrated	97.6	78.5	97.1	78.5	101.4	3.01	1.014
Potato, protein concentrate	89.4	59.0	89.0	59.8	100.7	3.01	1.002
Poultry fat	99.4	89.8	99.4	89.8	100.0	0.00	1.000
Rapeseed	97.0	78.3	96.3	78.9	102.3	3.01	0.976
Rapeseed meal	91.8	59.7	90.4	61.0	107.4	3.51	1.037
Rice bran, defatted	95.5	73.5	94.5	72.5	111.4	3.51	1.067
Rice bran, fat	96.8	80.6	96.1	79.2	107.4	3.51	1.051
Rice, broken	97.7	81.7	97.6	81.2	100.4	3.01	1.041
Rice, brown	97.8	80.0	97.6	80.0	100.3	3.01	1.005

	Growing		Adult		DEa/DEg	DEg➔ DEa	
Name	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Rye	97.0	77.3	96.2	77.5	102.6	3.01	1.034
Sesame meal	91.9	66.5	91.1	67.1	103.2	3.01	1.014
Sorghum	97.5	78.9	97.1	78.9	101.8	3.01	1.030
Soybean hulls	93.2	53.4	90.5	57.6	136.8	7.99	1.059
Soybean meal, 46	91.4	60.5	90.4	62.0	106.3	7.99	1.012
Soybean meal, 48	91.3	60.5	90.3	61.9	106.2	7.99	1.010
Soybean meal, 50	91.1	60.8	90.2	62.1	105.1	7.99	1.007
Soybean, full-fat, extruded	93.8	71.9	93.0	71.8	108.6	7.99	1.017
Soybean, full-fat, toasted	93.9	72.4	93.2	72.2	108.5	7.99	1.016
Starch, maize	98.8	81.7	98.5	81.9	100.0	0.00	1.000
Sunflower meal, decorticated	91.0	56.8	89.7	57.6	110.8	3.51	1.050
Sunflower meal, undercorticated	91.2	55.9	89.8	56.7	114.3	3.51	1.068
Sunflower seed	97.1	83.7	96.5	82.4	104.4	3.01	0.976
Sweet potato, dehydrated	98.1	79.3	97.7	79.3	101.5	3.01	1.017
Tallow	99.4	89.8	99.4	89.8	100.0	0.00	1.000
Triticale	97.1	78.4	96.6	78.4	101.7	2.51	1.031
Vegetable oil	99.4	89.8	99.4	89.8	100.0	0.00	1.000
Vinasse, different origins	90.8	59.9	90.6	59.8	100.0	0.00	1.000
Vinasse, from the production of glutamic acid	90.4	59.4	90.2	59.2	100.0	0.00	1.000
Vinasse, from yeast production	90.2	59.9	90.0	59.5	100.0	0.00	1.000
Wheat bran	94.8	70.8	93.6	70.6	110.4	3.01	1.068
Wheat bran, durum	94.9	72.5	93.8	71.5	112.3	3.01	1.078
Wheat distillers' grains, dark colour, L < 50	93.3	59.7	91.7	60.4	108.7	3.00	1.029
Wheat distillers' grains, light colour, L > 50	92.6	61.3	91.3	61.9	105.6	3.00	1.023
Wheat distillers' grains, starch < 7%	92.3	63.9	90.9	64.8	108.8	3.01	1.051
Wheat distillers' grains, starch > 7%	93.6	65.8	92.2	67.3	104.6	3.01	1.033
Wheat feed flour	96.9	77.0	96.5	77.2	101.3	3.01	1.025
Wheat gluten feed, starch 25%	95.1	70.3	93.7	71.6	105.0	3.01	1.042
Wheat gluten feed, starch 28%	95.4	70.9	94.2	71.7	105.7	3.01	1.046
Wheat middlings	95.3	72.2	94.3	72.3	106.9	3.01	1.049
Wheat middlings, durum	95.5	73.6	94.7	73.3	107.0	3.01	1.051
Wheat shorts	95.9	74.0	95.1	74.2	104.3	3.01	1.038
Wheat straw	88.6	54.2	87.5	54.1	155.7	1.51	1.000
Wheat, durum	96.5	76.8	96.0	76.7	102.2	3.01	1.029
Wheat, soft	97.0	78.3	96.6	78.2	101.8	3.01	1.029
Whey, acid, skimmed, dehydrated	97.1	81.7	96.9	80.9	100.0	0.00	1.041
Whey, sweet, dehydrated, skimmed	96.8	83.4	96.6	82.3	100.0	0.00	1.041
Yeast, brewers', dehydrated	91.5	62.4	90.1	64.0	102.3	3.01	1.011

- a (kJ/g) : DEa - DEg (MJ/kg) = (a / 1000) x Non digestible organic matter (g)
- b (unitless) : OMdg = b x Edg