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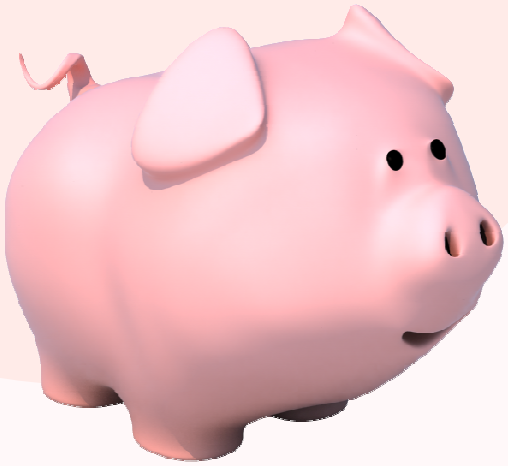

Equations and coefficients

Version 1.0

INRA

Association Française de Zootechnie

AJINOMOTO

AJINOMOTO ANIMAL NUTRITION

AJINOMOTO EUROLYSINE S.A.S.

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Credits and acknowledgments

EvaPig® was created, designed and developed by Jean Noblet (INRA, UMR SENAH), Alain Valancogne (INRA, UMR SENAH), Gilles Tran (AFZ) and AJINOMOTO EUROLYSINE S.A.S.

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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

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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).
- 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.

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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.

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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.

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

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:

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- 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

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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

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- 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

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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
```

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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 – 4.0 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)

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

Energy lost from urinary nitrogen (MJ and g per kg DM)

```
Growing pigs:    EUri = 0.19 + 0.031 x NUri
Adult pigs:      EUri = 0.22 + 0.031 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 = 6.7 x ResD
Adult pigs:      ECH4 = 13.4 x ResD
```

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
```

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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.

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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%.

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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% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 18-19% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 22-25% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, proteins < 16% dry matter	-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
Buckwheat hulls	-1.57	-0.90	-1.43
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
Cod liver oil	0.00	0.00	0.00
Copra meal	-1.57	-0.90	-1.43
Copra oil	0.00	0.00	0.00
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, anchovy	0.00	0.00	0.00
Fish oil, capelin	0.00	0.00	0.00
Fish oil, herring	0.00	0.00	0.00
Fish oil, menhaden	0.00	0.00	0.00
Fish oil, red fish (Sebastes)	0.00	0.00	0.00
Fish oil, salmon	0.00	0.00	0.00
Fish oil, sardine	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

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Name	Crude fibre	NDF	ADF
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	-1.57	-0.90	-1.43
Linseed meal, expeller extraction	-1.57	-0.90	-1.43
Linseed meal, solvent extraction	-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
Lupin, blue	-1.57	-0.90	-1.43
Lupin, white	-1.57	-0.90	-1.43
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 Analog MHA	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
Palm oil	0.00	0.00	0.00
Pea	-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
Rapeseed oil	0.00	0.00	0.00
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 oil	0.00	0.00	0.00
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

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Name	Crude fibre	NDF	ADF
Sunflower oil	0.00	0.00	0.00
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
Tryptophan	0.00	0.00	0.00
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, dehydrated, starch < 7%	-3.90	-0.92	-1.43
Wheat distillers' grains, dehydrated, 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

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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	0.7	4.33
Alfalfa, dehydrated, protein 17-18% dry matter	92.8	54.5	90.2	56.3	118.3	0.7	4.61
Alfalfa, dehydrated, protein 18-19% dry matter	92.8	55.2	90.3	56.9	117.4	0.7	4.59
Alfalfa, dehydrated, protein 22-25% dry matter	92.7	58.7	90.7	59.9	112.8	0.7	4.48
Alfalfa, dehydrated, proteins < 16% dry matter	92.7	53.0	90.0	55.1	120.5	0.7	4.66
Barley	96.8	76.7	96.1	76.8	102.7	0.6	4.33
Barley brewers' grains, dehydrated	92.3	67.9	91.0	67.5	109.8	0.6	4.46
Barley rootlets, dehydrated	93.0	64.6	91.6	65.1	107.7	0.6	4.42
Beet pulp, dehydrated	94.3	60.2	91.2	63.4	112.9	1.7	4.39
Beet pulp, dehydrated, molasses added	94.4	60.4	91.4	63.4	112.3	1.7	4.38
Beet pulp, pressed	94.1	59.7	90.9	63.0	113.0	1.7	4.39
Blood meal	89.4	56.2	89.3	56.6	100.0	0.0	4.18
Buckwheat hulls	91.2	46.3	88.3	47.2	128.5	0.5	5.17
Carob pod meal	96.7	70.5	95.9	69.3	109.5	0.5	4.55
Cassava, starch 67%	98.3	81.4	97.8	80.9	102.2	0.7	4.30
Cassava, starch 72%	98.4	80.5	98.0	80.4	101.3	0.7	4.19
Chickpea	96.0	75.1	95.5	75.1	103.7	1.4	4.28
Citrus pulp	95.6	64.6	93.2	66.9	111.3	1.7	4.38
Cocoa hulls	93.0	68.6	91.0	63.3	136.7	0.5	5.02
Cocoa meal, full extraction	92.3	61.1	90.6	62.0	108.7	0.7	4.41
Cod liver oil	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Copra meal	93.3	68.0	91.8	67.9	110.9	0.7	4.46
Copra oil	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Corn distillers, dehydrated	93.6	66.6	91.9	67.7	115.9	1.7	4.38
Corn gluten feed	94.2	67.0	92.5	68.1	116.4	1.7	4.40
Corn gluten meal	92.2	64.3	91.9	65.2	102.0	1.7	4.17
Cottonseed	95.0	71.0	93.6	70.8	107.2	0.7	4.29
Cottonseed meal, crude fibre 14-20%	91.3	57.9	89.9	59.3	106.5	0.7	4.33
Cottonseed meal, crude fibre 7-14%	90.8	60.1	90.0	61.0	104.8	0.7	4.27
DL-Methionine	94.9	77.1	94.8	77.1	100.0	0.0	4.18
Faba bean, coloured flowers	94.6	71.0	93.9	70.9	102.8	0.7	4.29
Faba bean, white flowers	94.4	70.4	93.8	70.4	102.2	0.7	4.27
Feather meal	90.0	60.6	89.9	60.4	100.0	0.0	4.18
Fish meal, protein 62%	90.5	65.0	90.3	64.8	100.0	0.0	4.18
Fish meal, protein 65%	90.5	64.8	90.3	64.6	100.0	0.0	4.18
Fish meal, protein 70%	90.4	64.5	90.3	64.2	100.0	0.0	4.18
Fish oil, anchovy	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish oil, capelin	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish oil, herring	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish oil, menhaden	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish oil, red fish (Sebastes)	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish oil, salmon	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish oil, sardine	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Fish protein concentrate, defatted	89.6	60.9	89.4	60.7	100.0	0.0	4.18
Fish protein concentrate, fat	91.9	69.4	91.8	69.1	100.0	0.0	4.18

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

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	Growing		Adult		DEa/DEg	DEg➔ DEa	
Name	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Grape seeds	94.4	66.2	91.9	64.6	112.8	0.5	4.71
Grapeseed oil meal	92.2	45.5	89.0	46.7	119.5	0.5	4.90
Grass, dehydrated	92.7	58.6	90.8	59.1	122.1	0.7	4.66
Groundnut meal	90.4	58.6	89.7	59.3	103.7	0.7	4.23
Groundnut meal, detoxified, crude fibre < 9%	91.2	61.3	90.4	62.1	102.7	0.7	4.22
Hominy feed	96.1	75.4	94.9	75.1	110.7	1.7	4.36
Lard	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Linseed	95.8	77.9	94.9	78.0	103.8	0.7	4.29
Linseed meal, expeller extraction	92.6	65.0	91.1	66.3	104.2	0.7	4.29
Linseed meal, solvent extraction	91.8	61.5	90.2	63.1	104.3	0.7	4.29
Liquid potato feed	96.0	73.2	94.7	74.3	102.4	1.0	4.22
L-Lysine HCL	90.9	77.9	90.8	77.9	100.0	0.0	4.18
L-Threonine	91.6	77.7	91.5	77.8	100.0	0.0	4.18
Lupin, blue	92.6	62.2	91.0	63.9	110.4	1.9	4.29
Lupin, white	92.9	64.4	91.6	65.7	105.9	1.4	4.26
Maize	97.6	80.1	97.1	79.6	104.0	1.7	4.31
Maize bran	96.0	75.8	94.5	72.3	138.4	1.7	4.62
Maize feed flour	97.0	77.9	96.0	76.9	111.7	1.7	4.37
Maize germ meal, deoiled	93.4	63.9	91.6	65.7	104.8	0.7	4.33
Maize germ meal, non deoiled	96.2	76.8	95.2	77.0	104.0	0.7	4.33
Meat and bone meal, fat < 7.5%	88.3	63.8	88.1	62.6	100.0	0.0	4.18
Meat and bone meal, fat > 7.5%	89.7	68.9	89.5	67.9	100.0	0.0	4.18
Methionine Hydroxy Analog MHA	94.9	77.1	94.8	77.1	100.0	0.0	4.18
Milk powder, skimmed	94.1	73.3	93.9	73.1	100.0	0.0	4.30
Milk powder, unskimmed	96.5	78.9	96.4	79.2	100.0	0.0	4.23
Molasses, beet	97.2	68.5	97.0	68.6	103.0	0.7	4.18
Molasses, sugarcane	98.1	69.9	97.8	70.3	103.0	0.7	4.18
Oats	96.2	74.9	95.2	74.5	106.3	0.6	4.42
Oats, decorticated	96.8	76.5	96.1	76.7	102.1	0.6	4.32
Palm kernel meal	92.6	68.6	90.6	68.0	118.0	0.7	4.62
Palm oil	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Pea	95.3	73.2	94.6	73.1	103.6	1.4	4.28
Potato pulp, dehydrated	96.6	72.1	95.0	72.2	107.8	1.0	4.35
Potato tuber, dehydrated	97.6	78.5	97.1	78.5	101.4	0.7	4.24
Potato, protein concentrate	89.4	59.0	89.0	59.8	100.7	0.7	4.19
Poultry fat	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Rapeseed	97.0	78.3	96.3	78.9	102.3	0.7	4.08
Rapeseed meal	91.7	59.7	90.4	61.0	107.4	0.8	4.34
Rapeseed oil	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Rice bran, defatted	95.5	73.5	94.5	72.5	111.4	0.8	4.46
Rice bran, fat	96.8	80.6	96.1	79.2	107.4	0.8	4.40
Rice, broken	97.7	81.7	97.6	81.2	100.4	0.7	4.36
Rice, brown	97.8	80.0	97.6	80.0	100.3	0.7	4.20
Rye	97.0	77.3	96.2	77.5	102.6	0.7	4.33
Sesame meal	91.9	66.5	91.1	67.1	103.2	0.7	4.24
Sorghum	97.5	78.9	97.1	78.9	101.8	0.7	4.31
Soybean hulls	93.2	53.4	90.5	57.6	136.8	1.9	4.43

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- b (unitless) : OMdg = b x Edg

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	Growing		Adult		DEa/DEg	DEg➔ DEa	
Name	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Soybean meal, 46	91.4	60.5	90.3	62.0	106.3	1.9	4.23
Soybean meal, 48	91.3	60.5	90.3	61.9	106.2	1.9	4.23
Soybean meal, 50	91.1	60.8	90.2	62.1	105.0	1.9	4.21
Soybean oil	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Soybean, full-fat, extruded	93.8	71.9	93.0	71.8	108.6	1.9	4.26
Soybean, full-fat, toasted	93.9	72.4	93.2	72.2	108.5	1.9	4.25
Starch, maize	98.8	81.7	98.5	81.9	100.0	0.0	4.18
Sunflower meal, decorticated	91.0	56.8	89.7	57.6	110.8	0.8	4.39
Sunflower meal, undercorticated	91.2	55.9	89.7	56.7	114.3	0.8	4.47
Sunflower oil	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Sunflower seed	97.1	83.7	96.5	82.4	104.4	0.7	4.08
Sweet potato, dehydrated	98.1	79.3	97.7	79.3	101.5	0.7	4.26
Tallow	99.4	89.7	99.3	89.8	100.0	0.0	4.18
Triticale	97.1	78.4	96.6	78.3	101.7	0.6	4.31
Tryptophan	94.0	77.3	93.9	77.3	100.0	0.0	4.18
Vinasse, different origins	90.8	59.9	90.6	59.8	100.0	0.0	4.18
Vinasse, from the production of glutamic acid	90.4	59.4	90.2	59.2	100.0	0.0	4.18
Vinasse, from yeast production	90.2	59.9	90.0	59.5	100.0	0.0	4.18
Wheat bran	94.8	70.8	93.6	70.6	110.4	0.7	4.47
Wheat bran, durum	94.9	72.5	93.8	71.5	112.3	0.7	4.51
Wheat distillers' grains, dehy., starch < 7%	92.3	63.9	90.9	64.8	108.8	0.7	4.40
Wheat distillers' grains, dehy., starch > 7%	93.6	65.8	92.2	67.3	104.5	0.7	4.32
Wheat feed flour	96.9	77.0	96.5	77.2	101.3	0.7	4.29
Wheat gluten feed, starch 25%	95.1	70.3	93.7	71.6	105.0	0.7	4.36
Wheat gluten feed, starch 28%	95.4	70.9	94.2	71.7	105.7	0.7	4.38
Wheat middlings	95.3	72.2	94.3	72.3	106.8	0.7	4.39
Wheat middlings, durum	95.5	73.6	94.7	73.3	107.0	0.7	4.40
Wheat shorts	95.9	74.0	95.1	74.2	104.3	0.7	4.34
Wheat straw	88.6	54.2	87.5	54.1	155.7	0.4	4.18
Wheat, durum	96.5	76.8	96.0	76.7	102.2	0.7	4.31
Wheat, soft	97.0	78.3	96.5	78.2	101.8	0.7	4.31
Whey, acid, skimmed, dehydrated	97.1	81.7	96.9	80.9	100.0	0.0	4.36
Whey, sweet, dehydrated, skimmed	96.8	83.4	96.6	82.3	100.0	0.0	4.36
Yeast, brewers', dehydrated	91.4	62.4	90.1	64.0	102.3	0.7	4.23

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