

EvaPig®

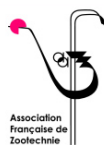
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Equations and coefficients

INRAE



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Credits and acknowledgments

EvaPig® has been created, designed, and developed by Jean Noblet (INRAE; retired), Alain Valancogne (INRAE), Gilles Tran (AFZ) and Ajinomoto Animal Nutrition Europe.



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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.

This new edition of EvaPig® includes 256 reference ingredients vs. 132 in the previous one, as well as values for macro minerals and electrolyte balance. The calculation bases are unchanged compared to the previous version.

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 similar for ingredients and diets and will be presented in the same chapter.

Units and abbreviations

Except when noted otherwise, the equations and coefficients in this document 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

Abbreviation	Full name
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 detergent fibre
NE	Net energy
NEa	Net energy for adult pigs
NEg	Net energy for growing pigs
NUri	Nitrogen lost in urine
OMd	<i>In vivo</i> organic matter digestibility
OMdg	<i>In vivo</i> organic matter digestibility for growing pigs
OMdv	<i>In vitro</i> 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 nutrients in a diet or an ingredient should not be higher than 115% with NDF as the fibrous fraction indicator. When the NDF analysis is absent, it is estimated as 2.5 x ADF (if present) or 3 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.

Ingredient creation based on a reference ingredient

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:

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

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.

Energy values

Calculation outline

The calculation of energy values involves the following steps:

- $GE = f(\text{protein, fat, ash})$
- $Ed = f(\text{fibre})$
- $DE = GE \times Ed$
- $DEa = f(DEg, Edg, \text{ash})$

- $ME/DE = f(\text{protein}, DE)$
- $ME = DE \times ME/DE$
- $NE/ME = f(\text{protein}, \text{fat}, \text{starch}, ME)$
- $NE = ME \times NE/ME$

Gross energy

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

$$GE_{\text{New}} = GE_{\text{Ref}} + 0.0616 \times (\text{Protein}_{\text{New}} - \text{Protein}_{\text{Ref}}) + 0.2192 \times (\text{Fat}_{\text{New}} - \text{Fat}_{\text{Ref}}) - 0.1866 \times (\text{Ash}_{\text{New}} - \text{Ash}_{\text{Ref}})$$

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.

$$Ed_{\text{New}} = Ed_{\text{Ref}} + a \times (\text{Fibre}_{\text{New}} - \text{Fibre}_{\text{Ref}})$$

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:

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

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

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

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:

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

Digestible energy is calculated as follows:

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

Metabolizable / digestible energy ratio

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

$$ME/DE_{\text{New}} = ME/DE_{\text{Ref}} - 1.98 \times (\text{Protein}_{\text{New}} - \text{Protein}_{\text{Ref}}) / DE_{\text{New}}$$

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

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.

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.

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 in the table below.

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

Electrolyte balance

The electrolyte balance (EB) is calculated from the values of sodium (Na), potassium (K), and chlorine (Cl). EB is expressed in mEq/kg DM and the minerals are expressed in % DM.

$$EB = 1000 \times (10 \times Na / 23 + 10 \times K / 39 - 10 \times Cl / 35.5)$$

Note: Electrolyte balance is not recalculated when values of Na, K, and Cl are changed.

Diets created from a list of ingredients

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.

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) forms
- 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

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

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:

$$\text{Phytase}_{\text{Endo}} = f(dP_{\text{Mash}} - dP_{\text{Pellet}}) \text{ where } f \text{ is Equation \#2}$$

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

$$\text{Phytase}_{\text{Total}} = \text{Phytase}_{\text{Exo}} + \text{Phytase}_{\text{Endo}}$$

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

$$P_{\text{ReleasedTotal}} = f(\text{Phytase}_{\text{Total}}) \text{ where } f \text{ is Equation \#1}$$

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:

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

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:

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

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.

Energy values

Calculation outline

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

- $GE = f(\text{protein, fat, ash, fibre, sugars, starch})$; GE value can also be provided and it will be used instead of GE calculated from chemical characteristics.
- $\text{Ingredient } Ed = f(\text{fibre})$; ash should not be used
- $\text{Diet } Ed = f(\text{fibre, ash, in vitro digestible organic matter})$
- $DE = GE \times Ed$
- $DEa = f(DEg, Edg, \text{ash, protein})$
- $\text{Energy lost from urine} = f(\text{protein})$
- $\text{Energy lost as methane} = f(\text{ash, protein, fat, starch, sugars})$
- $ME = f(DE, \text{Energy urine, Energy methane})$
- $NE = f(DE, \text{protein, fat, starch, fibre})$

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

Gross energy

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

Equations requiring fibre and sugars

$$GE = 17.56 + 0.0551 \times \text{Protein} + 0.2148 \times \text{Fat} + 0.0259 \times \text{Crude fibre} - 0.1774 \times \text{Ash} - 0.0114 \times \text{Sugars}$$

$$GE = 17.56 + 0.0545 \times \text{Protein} + 0.2150 \times \text{Fat} + 0.0216 \times \text{ADF} - 0.1769 \times \text{Ash} - 0.0115 \times \text{Sugars}$$

$$GE = 17.41 + 0.0579 \times \text{Protein} + 0.2163 \times \text{Fat} - 0.1812 \times \text{Ash} + 0.0148 \times \text{NDF} - 0.0072 \times \text{Sugars}$$

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

$$GE = 17.57 + 0.0535 \times \text{Protein} + 0.2168 \times \text{Fat} + 0.0284 \times \text{Crude fibre} - 0.1861 \times \text{Ash}$$

$$GE = 17.58 + 0.0529 \times \text{Protein} + 0.2171 \times \text{Fat} + 0.0238 \times \text{ADF} - 0.1858 \times \text{Ash}$$

$$GE = 17.40 + 0.0573 \times \text{Protein} + 0.2176 \times \text{Fat} + 0.0161 \times \text{NDF} - 0.1873 \times \text{Ash}$$

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

Equation without fibre

$$GE = 18.88 + 0.0424 \times \text{Protein} + 0.2025 \times \text{Fat} - 0.2037 \times \text{Ash} - 0.0142 \times \text{Starch} - 0.0238 \times \text{Sugars}$$

Equation without fibre and sugars

$$GE = 18.47 + 0.0414 \times \text{Protein} + 0.2108 \times \text{Fat} - 0.1964 \times \text{Ash} - 0.0092 \times \text{Starch}$$

Equation without fibre and starch

$$GE = 17.61 + 0.0505 \times \text{Protein} + 0.2153 \times \text{Fat} - 0.1506 \times \text{Ash} - 0.0148 \times \text{Sugars}$$

Equation without fibre, sugars, and starch

$$GE = 17.64 + 0.0478 \times \text{Protein} + 0.2180 \times \text{Fat} - 0.1588 \times \text{Ash}$$

Energy digestibility

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

For ingredients and diets

$$\text{Edg} = 90.1 - 1.57 \times \text{Crude fibre}$$

$$\text{Edg} = 98.3 - 0.90 \times \text{NDF}$$

$$\text{Edg} = 90.8 - 1.43 \times \text{ADF}$$

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

$$\text{Edg} = 98.0 - 1.60 \times \text{Ash} - 1.26 \times \text{Crude fibre}$$

$$\text{Edg} = 102.6 - 1.06 \times \text{Ash} - 0.79 \times \text{NDF}$$

$$\text{Edg} = 97.9 - 1.46 \times \text{Ash} - 1.17 \times \text{ADF}$$

Equations with OMdv (%), fibre and ash

$$\text{Edg} = 35.5 + 0.64 \times \text{OMdv} - 0.68 \times \text{Crude fibre} - 0.68 \times \text{Ash}$$

$$\text{Edg} = 41.0 + 0.58 \times \text{OMdv} - 0.74 \times \text{ADF} - 0.64 \times \text{Ash}$$

Equations with OMdv and fibre

$$\text{Edg} = 30.1 + 0.66 \times \text{OMdv} - 0.77 \times \text{Crude fibre}$$

$$\text{Edg} = 36.2 + 0.60 \times \text{OMdv} - 0.82 \times \text{ADF}$$

Equations with OMdv only

$$\text{Edg} = 0.976 \times \text{OMdv}$$

Adult pigs

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

$$\text{OMd} = (7.45 + 0.949 \times \text{Edg} - 4.0 \times \text{Protein})$$

$$\text{DEa} = \text{DEg} + 4.2 \times (1 - \text{Ash} / 100) \times (1 - \text{OMd} / 100)$$

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)

$$\text{NUri} = 0.4 \times \text{Protein} / 6.25$$

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

$$\text{Growing pigs: } \text{EUri} = 0.19 + 0.031 \times \text{NUri}$$

$$\text{Adult pigs: } \text{EUri} = 0.22 + 0.031 \times \text{NUri}$$

Residue

$$\text{Res} = 100 - \text{Ash} - \text{Protein} - \text{Fat} - \text{Starch} - \text{Sugars}$$

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

Digestible residue

$$\text{Growing pigs: } \text{ResD} = 0.5 \times \text{Res}$$

$$\text{Adult pigs: } \text{ResD} = 0.6 \times \text{Res}$$

Energy lost as methane

$$\text{Growing pigs: } \text{ECH4} = 6.7 \times \text{ResD}$$

$$\text{Adult pigs: } \text{ECH4} = 13.4 \times \text{ResD}$$

Metabolizable energy

$$\text{Growing pigs: } \text{MEg} = \text{DEg} - \text{EUri} - \text{ECH4}$$

$$\text{Adult pigs: } \text{MEa} = \text{DEa} - \text{EUri} - \text{ECH4}$$

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).

$$NE = 0.703 \times DE - 0.0404 \times \text{Protein} + 0.0662 \times \text{Fat} + 0.0197 \times \text{Starch} - 0.0409 \times \text{Crude fibre}$$

$$NE = 0.703 \times DE + 0.0410 \times \text{Protein} + 0.0664 \times \text{Fat} + 0.0197 \times \text{Starch} - 0.0134 \times \text{NDF}$$

$$NE = 0.700 \times DE - 0.0382 \times \text{Protein} + 0.0674 \times \text{Fat} + 0.0202 \times \text{Starch} - 0.0365 \times \text{ADF}$$

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

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

$$Nd = 76.8 + 0.69 \times \text{Protein} - 1.22 \times \text{Crude fibre}$$

$$Nd = 81.3 + 0.79 \times \text{Protein} - 0.69 \times \text{NDF}$$

$$Nd = 77.4 + 0.70 \times \text{Protein} - 1.16 \times \text{ADF}$$

Adult pigs

$$Nd = 77.9 + 0.77 \times \text{Protein} - 0.87 \times \text{Crude fibre}$$

$$Nd = 79.9 + 0.86 \times \text{Protein} - 0.44 \times \text{NDF}$$

$$Nd = 78.3 + 0.78 \times \text{Protein} - 0.83 \times \text{ADF}$$

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

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

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.

Fibre coefficients for predicting energy digestibility

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	-0.90	-1.43
Alfalfa, dehydrated, protein < 16% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein > 25% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 16-18% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 17-19% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 19-22% dry matter	-1.57	-0.90	-1.43
Alfalfa, dehydrated, protein 22-25% dry matter	-1.57	-0.90	-1.43
Apple pomace, dehydrated	-1.57	-0.90	-1.43
Bakery byproducts	-1.57	-0.90	-1.43
Bananas, dehydrated	-1.57	-0.90	-1.43
Barley	-2.53	-0.90	-1.72
Barley distillers grains, dried	-2.53	-0.90	-1.72
Barley distillers grains, fresh, whisky production	-2.53	-0.90	-1.72
Barley rootlets, dried	-2.53	-0.90	-1.72
Beet pulp, dried	-1.57	-0.90	-1.43
Beet pulp, pressed	-1.57	-0.90	-1.43
Biscuit by-products	-1.57	-0.90	-1.43
Brewers' dried grains	-2.53	-0.90	-1.72
Brewers' yeast, dried	-1.57	-0.90	-1.43
Buckwheat hulls	-1.57	-0.90	-1.43
Camelina oil meal, oil > 5%	-1.57	-0.90	-1.43
Canola meal, oil < 5%	-1.57	-1.21	-1.34
Carob pod meal	-1.57	-0.90	-1.43
Cassava, starch 66-70%	-1.66	-0.90	-1.43
Cassava, starch 70-74%	-1.66	-0.90	-1.43
Cereal offal, crude fibre > 14%	-1.57	-0.90	-1.43
Cereal offal, crude fibre 5-14%	-1.57	-0.90	-1.43
Chickpea, Kabuli type	-1.57	-0.90	-1.43
Chicory pulp, dehydrated	-1.57	-0.90	-1.43
Citrus pulp, dried	-1.57	-0.90	-1.43

Name	Crude fibre	NDF	ADF
Citrus pulp, fresh	-1.57	-0.90	-1.43
Cocoa hulls	-1.57	-0.90	-1.43
Cocoa meal, oil < 5%	-1.57	-0.90	-1.43
Common bean	-1.57	-0.90	-1.43
Common vetch	-1.57	-0.90	-1.43
Copra meal, oil < 5%	-1.57	-0.90	-1.43
Copra meal, oil 5-20%	-1.57	-0.90	-1.43
Corn gluten feed	-3.93	-0.90	-3.11
Corn gluten meal	-3.93	-0.90	-3.11
Cottonseed hulls	-1.57	-0.90	-1.43
Cottonseed meal, oil < 5%, crude fibre < 15%	-1.57	-0.90	-1.43
Cottonseed meal, oil < 5%, crude fibre 15-20%	-1.57	-0.90	-1.43
Cottonseed meal, oil 5-20%, crude fibre < 15%	-1.57	-0.90	-1.43
Cottonseed meal, oil 5-20%, crude fibre 15-20%	-1.57	-0.90	-1.43
Cottonseed, full fat	-1.57	-0.90	-1.43
Cottonseed, full fat, extruded	-1.57	-0.90	-1.43
Cowpea	-1.57	-0.90	-1.43
Faba bean, coloured flowers	-1.57	-0.90	-1.43
Faba bean, coloured flowers, extruded	-1.57	-0.90	-1.43
Faba bean, white flowers	-1.57	-0.90	-1.43
Fodder beet, raw	-1.57	-0.90	-1.43
Grape pomace, dried	-1.57	-0.90	-1.43
Grape pulp, dried	-1.57	-0.90	-1.43
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, oil < 5%, crude fibre < 9%	-1.57	-0.90	-1.43
Groundnut meal, oil < 5%, crude fibre > 9%	-1.57	-0.90	-1.43
Groundnut meal, oil 5-20%	-1.57	-0.90	-1.43
Jatropha oil meal, oil < 5%, dehulled, detoxified	-1.57	-0.90	-1.43
Lentils	-1.57	-0.90	-1.43
Linseed meal, oil < 5%	-1.57	-0.90	-1.43
Linseed meal, oil > 5%	-1.57	-0.90	-1.43
Linseed, full fat	-1.57	-0.90	-1.43
Linseed, full fat, extruded	-1.57	-0.90	-1.43
Liquid potato feed	-1.57	-0.90	-1.43
Lupin, blue	-1.57	-0.90	-1.43
Lupin, white	-1.57	-0.90	-1.43
Lupin, white, extruded	-1.57	-0.90	-1.43
Maize	-3.83	-0.90	-3.11

Name	Crude fibre	NDF	ADF
Maize bran	-3.93	-0.90	-3.11
Maize distillers grains with solubles, oil < 6 %, dried	-3.93	-0.90	-3.11
Maize distillers grains with solubles, oil > 6%, dried	-3.93	-0.90	-3.11
Maize feed flour	-3.93	-0.90	-3.11
Maize flour, crude fibre < 2%	-3.93	-0.90	-3.11
Maize germ meal, oil < 5%	-3.93	-0.90	-3.11
Maize germ meal, oil 5-20%	-3.93	-0.90	-3.11
Maize germs, oil > 30%	-3.93	-0.90	-3.11
Maize germs, oil 14-30%	-3.93	-0.90	-3.11
Maize processing by-product, protein 8-18%, oil < 5%	-3.93	-0.90	-3.11
Maize processing by-product, protein 8-18%, oil 5-14%	-3.93	-0.90	-3.11
Maize starch	-1.57	-0.90	-1.43
Maize starch by-product	-3.93	-0.90	-3.11
Maize, extruded	-3.83	-0.90	-3.11
Maize, flaked	-3.83	-0.90	-3.11
Maize, high moisture	-3.83	-0.90	-3.11
Millet, common	-1.57	-0.90	-1.43
Millet, pearl	-1.57	-0.90	-1.43
Molasses, beet	-1.57	-0.90	-1.43
Molasses, sugarcane	-1.57	-0.90	-1.43
Mustard bran	-1.57	-0.90	-1.43
Oat groats	-2.13	-0.90	-1.43
Oat hulls	-1.57	-0.90	-1.43
Oats	-2.13	-0.90	-1.43
Oats, flaked	-2.13	-0.90	-1.43
Olive oil cake, with pits, oil < 5%	-1.57	-0.90	-1.43
Olive oil cake, with pits, oil > 5%	-1.57	-0.90	-1.43
Olive pulp, oil < 10%	-1.57	-0.90	-1.43
Olive pulp, oil > 10%	-1.57	-0.90	-1.43
Palm kernel meal, oil < 5%	-1.57	-0.90	-1.43
Palm kernel meal, oil 5-20%	-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 cream	-1.57	-0.90	-1.43
Pea protein concentrate	-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
Pea, extruded	-1.57	-0.90	-1.43
Potato protein concentrate	-1.57	-0.90	-1.43
Potato pulp, dried	-1.57	-0.90	-1.43

Name	Crude fibre	NDF	ADF
Potato tuber, dried	-1.57	-0.90	-1.43
Rapeseed meal, oil < 5%	-1.57	-1.21	-1.34
Rapeseed meal, oil 5-20%	-1.57	-1.21	-1.34
Rapeseed, full fat	-1.57	-0.90	-1.43
Rapeseed, full fat, extruded	-1.57	-0.90	-1.43
Rice bran, oil < 5%, crude fibre > 20%	-1.57	-0.90	-1.43
Rice bran, oil < 5%, crude fibre 11-20%	-1.57	-0.90	-1.43
Rice bran, oil < 5%, crude fibre 5-11%	-1.57	-0.90	-1.43
Rice bran, oil > 5%, crude fibre > 20%	-1.57	-0.90	-1.43
Rice bran, oil > 5%, crude fibre 11-20%	-1.57	-0.90	-1.43
Rice bran, oil > 5%, crude fibre 5-11%	-1.57	-0.90	-1.43
Rice hulls	-1.57	-0.90	-1.43
Rice shorts, oil < 5%, crude fibre < 5%	-1.57	-0.90	-1.43
Rice shorts, oil > 5%, crude fibre < 5%	-1.57	-0.90	-1.43
Rice, brown	-1.57	-0.90	-1.43
Rice, paddy	-1.57	-0.90	-1.43
Rice, polished, broken	-1.57	-0.90	-1.43
Rye	-1.57	-0.90	-1.43
Sesame meal, oil > 5%	-1.57	-0.90	-1.43
Sheanut oil meal, oil > 5%	-1.57	-0.90	-1.43
Sorghum	-1.57	-0.90	-1.43
Soybean hulls	-1.01	-0.71	-1.43
Soybean meal, oil < 5%, 46% protein + oil	-1.01	-0.71	-1.43
Soybean meal, oil < 5%, 48% protein + oil	-1.01	-0.71	-1.43
Soybean meal, oil < 5%, 48% protein + oil, extruded	-1.01	-0.71	-1.43
Soybean meal, oil < 5%, 50% protein + oil	-1.01	-0.71	-1.43
Soybean meal, oil 5-20%	-1.01	-0.71	-1.43
Soybean molasses	-1.57	-0.90	-1.43
Soybean protein concentrate, protein 50-60%	-1.01	-0.71	-1.43
Soybean protein concentrate, protein 60-70%	-1.01	-0.71	-1.43
Soybean protein concentrate, protein 70-90%	-1.01	-0.71	-1.43
Soybean, full fat, extruded	-1.57	-0.90	-1.43
Soybean, full fat, flaked	-1.57	-0.90	-1.43
Soybean, full fat, toasted	-1.57	-0.90	-1.43
Soybean, full fat, toasted, flaked and expanded	-1.57	-0.90	-1.43
Sunflower hulls	-1.57	-0.90	-1.43
Sunflower meal, oil < 5%, dehulled	-1.27	-1.04	-1.32
Sunflower meal, oil < 5%, non dehulled	-1.27	-1.04	-1.32
Sunflower meal, oil > 5 %, protein > 30%	-1.27	-1.04	-1.32
Sunflower meal, oil > 5%, protein < 30%	-1.27	-1.04	-1.32

Name	Crude fibre	NDF	ADF
Sunflower seed, full fat	-1.57	-0.90	-1.43
Sweet potato, dried	-1.57	-0.90	-1.43
Tomato pulp, dehydrated	-1.57	-0.90	-1.43
Triticale	-3.33	-0.90	-1.43
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, protein 30 %	-1.57	-0.90	-1.43
Vinasse, from yeast production, protein 40%	-1.57	-0.90	-1.43
Vinasse, from yeast production, protein 48%	-1.57	-0.90	-1.43
Wheat bran	-3.90	-0.92	-1.43
Wheat bran from starch production	-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%, dried	-3.90	-0.92	-1.43
Wheat distillers' grains, starch > 7%, dried	-3.90	-0.92	-1.43
Wheat feed flour	-3.90	-0.92	-1.43
Wheat feed flour, durum	-3.90	-0.92	-1.43
Wheat feed flour, durum, from semolina	-3.90	-0.92	-1.43
Wheat gluten	-3.90	-0.92	-1.43
Wheat gluten feed, type 20% starch	-3.90	-0.92	-1.43
Wheat gluten feed, type 30% starch	-3.90	-0.92	-1.43
Wheat middlings, all types except durum	-3.90	-0.92	-1.43
Wheat middlings, durum	-3.90	-0.92	-1.43
Wheat middlings, starch < 20%	-3.90	-0.92	-1.43
Wheat middlings, starch > 40%	-3.90	-0.92	-1.43
Wheat middlings, starch 20-30%	-3.90	-0.92	-1.43
Wheat middlings, starch 30-40%	-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

Energy ratios

Table 6. Energy ratios (%) and coefficients for converting DE in growing pig to DE in adult pig (see calculations at the bottom of the table)

Name	Growing		Adult		DEa/DEg	DEg → DEa	
	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Alfalfa protein concentrate	91.4	64.3	90.7	65.1	103.1	3.0	1.03
Alfalfa, dehydrated, protein < 16% dry matter	93.3	54.9	90.6	55.9	108.9	1.5	1.13
Alfalfa, dehydrated, protein > 25% dry matter	92.7	58.2	90.8	58.6	106.7	1.5	1.10
Alfalfa, dehydrated, protein 16-18% dry matter	93.3	55.2	90.7	56.0	108.7	1.5	1.13
Alfalfa, dehydrated, protein 17-19% dry matter	93.2	55.6	90.7	56.5	108.3	1.5	1.13
Alfalfa, dehydrated, protein 19-22% dry matter	93.1	57.1	90.7	58.1	107.4	1.5	1.11
Alfalfa, dehydrated, protein 22-25% dry matter	93.0	58.3	90.9	59.2	106.7	1.5	1.11
Apple pomace, dehydrated	94.7	61.8	92.2	63.2	113.2	3.0	1.09
Bakery byproducts	97.2	76.5	96.7	77.1	100.7	3.0	1.02
Bananas, dehydrated	97.7	79.8	97.0	79.9	101.2	3.0	1.03
Barley	96.8	76.6	96.1	76.7	102.8	2.5	1.04
Barley distillers grains, dried	92.9	64.2	91.3	65.8	105.8	2.5	1.04
Barley distillers grains, fresh, whisky production	92.8	64.3	90.8	65.4	111.8	2.5	1.09
Barley rootlets, dried	93.4	66.7	92.3	66.6	107.7	2.5	1.06
Beet pulp, dried	94.3	60.6	91.3	63.7	113.5	7.0	1.05
Beet pulp, pressed	94.1	59.8	90.9	63.1	115.0	7.0	1.05
Biscuit by-products	97.6	76.9	97.1	77.6	100.8	3.0	1.02
Black soldier fly larvae, dehydrated, fat < 20 %	91.4	64.6	91.1	64.1	100.0	0.0	1.03
Black soldier fly larvae, dehydrated, fat > 20 %	94.6	76.6	94.2	76.4	100.0	0.0	1.03
Blood meal	114.9	57.1	89.4	57.5	128.4	0.0	0.99
Brewers' dried grains	92.6	67.8	91.3	67.7	109.1	2.5	1.06
Brewers' yeast, dried	91.9	64.4	90.8	65.6	102.3	3.0	1.01
Buckwheat hulls	92.5	47.4	89.4	48.0	122.4	2.0	1.19
Camelina oil meal, oil > 5%	93.3	68.3	92.4	68.7	104.7	3.5	1.02
Canola meal, oil < 5%	92.2	62.8	91.3	63.3	105.7	3.5	1.03
Carob pod meal	96.7	70.9	96.0	69.2	111.4	2.0	1.10
Cassava, starch 66-70%	98.4	80.3	98.0	80.1	102.1	3.0	1.00
Cassava, starch 70-74%	98.4	80.9	98.0	80.7	101.3	3.0	1.01
Cereal offal, crude fibre > 14%	95.5	81.4	94.9	74.8	126.6	3.0	1.15
Cereal offal, crude fibre 5-14%	96.3	77.6	95.5	75.2	112.5	3.0	1.08
Chickpea, Kabuli type	96.1	75.0	95.5	75.1	103.9	6.0	1.02
Canola meal, oil < 5%	92.2	62.8	91.3	63.3	105.7	3.5	1.03

- a (kJ/g): $DEa - DEg \text{ (MJ/kg)} = (a / 1000) \times \text{Non digestible organic matter (g)}$
- b (unitless): $OMdg = b \times Edg$

Name	Growing		Adult		DEa/DEg	DEg → DEa	
	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Carob pod meal	96.7	70.9	96.0	69.2	111.4	2.0	1.10
Cassava, starch 66-70%	98.4	80.3	98.0	80.1	102.1	3.0	1.00
Cassava, starch 70-74%	98.4	80.9	98.0	80.7	101.3	3.0	1.01
Cereal offal, crude fibre > 14%	95.5	81.4	94.9	74.8	126.6	3.0	1.15
Cereal offal, crude fibre 5-14%	96.3	77.6	95.5	75.2	112.5	3.0	1.08
Chickpea, Kabuli type	96.1	75.0	95.5	75.1	103.9	6.0	1.02
Chicory pulp, dehydrated	94.3	60.1	91.4	63.2	118.0	7.0	1.06
Citrus pulp, dried	95.9	65.5	93.7	67.4	110.5	7.0	1.05
Citrus pulp, fresh	96.0	66.6	93.8	68.6	109.4	7.0	1.04
Cocoa hulls	91.9	73.5	90.3	65.8	136.3	2.0	1.30
Cocoa meal, oil < 5%	92.5	61.7	90.8	62.8	108.4	3.0	1.05
Cod liver oil	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Common bean	94.6	71.5	93.7	71.9	103.7	6.0	1.02
Common vetch	93.9	72.2	93.3	71.9	106.0	6.0	1.02
Copra meal, oil < 5%	93.6	61.2	91.5	63.6	104.3	3.0	1.04
Copra meal, oil 5-20%	94.4	65.4	92.6	67.3	104.1	3.0	1.04
Copra oil	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Corn gluten feed	94.2	66.8	92.5	67.9	118.1	7.0	1.05
Corn gluten meal	92.3	62.8	91.9	64.1	103.1	7.0	1.00
Cottonseed hulls	92.3	46.2	89.7	49.6	147.4	3.5	1.23
Cottonseed meal, oil < 5%, crude fibre < 15%	90.8	60.5	90.0	61.3	104.7	3.0	1.02
Cottonseed meal, oil < 5%, crude fibre 15-20%	91.5	59.2	90.3	60.2	106.5	3.0	1.04
Cottonseed meal, oil 5-20%, crude fibre < 15%	91.8	65.6	91.3	66.0	104.0	3.0	1.02
Cottonseed meal, oil 5-20%, crude fibre 15-20%	92.5	62.7	91.3	63.5	106.4	3.0	1.04
Cottonseed, full fat	95.1	71.1	93.7	70.6	108.0	3.0	1.03
Cottonseed, full fat, extruded	95.2	70.8	93.7	70.5	107.6	3.0	1.03
Cowpea	94.8	73.0	94.1	73.0	103.9	6.0	1.02
DL-Methionine	94.9	77.1	94.8	77.1	100.0	0.0	1.00
Faba bean, coloured flowers	94.6	71.0	93.9	70.9	102.8	3.0	1.02
Faba bean, coloured flowers, extruded	94.6	70.9	93.9	70.9	102.6	3.0	1.02
Faba bean, white flowers	94.4	70.3	93.8	70.4	102.1	3.0	1.02
Feather meal	90.1	61.9	89.9	61.6	100.0	0.0	1.00
Fish meal, protein 62%	90.6	65.1	90.5	64.9	100.0	0.0	1.00
Fish meal, protein 65%	90.4	64.7	90.3	64.4	100.0	0.0	1.00
Fish meal, protein 70%	90.3	64.2	90.2	64.3	100.0	0.0	1.00
Fish oil, anchovy	99.4	89.6	99.4	89.4	100.0	0.0	1.00

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

Name	Growing Adult		Adult		DEa/DEg	DEg → DEa	
	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Fish oil, capelin	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Fish oil, herring	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Fish oil, menhaden	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Fish oil, red fish (Sebastes)	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Fish oil, salmon	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Fish oil, sardine	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Fish solubles, condensed, defatted	90.3	64.0	90.1	63.8	100.0	0.0	1.00
Fish solubles, condensed, fat	91.7	69.1	91.6	68.8	100.0	0.0	1.00
Fodder beet, raw	97.4	69.0	96.6	68.9	107.8	7.0	1.04
Grape pomace, dried	93.4	62.0	90.8	63.3	115.2	3.0	1.10
Grape pulp, dried	94.2	63.4	91.9	64.6	111.9	3.0	1.08
Grape seeds	94.8	66.1	92.3	65.0	116.6	3.0	1.11
Grapeseed oil meal	93.0	48.0	90.1	50.1	124.2	3.0	1.15
Grass, dehydrated	92.8	59.3	91.0	59.6	122.1	3.0	1.13
Groundnut meal, oil < 5%, crude fibre < 9%	91.2	62.3	90.8	62.6	102.9	3.0	1.01
Groundnut meal, oil < 5%, crude fibre > 9%	91.3	60.3	90.7	60.6	103.9	3.0	1.02
Groundnut meal, oil 5-20%	92.8	66.7	92.3	67.1	102.9	3.0	1.01
Jatropha oil meal, oil < 5%, dehulled, detoxified	89.4	61.8	89.6	61.6	102.6	3.5	1.00
Lard	99.4	89.9	99.3	89.7	100.0	0.0	1.00
Lentils	94.6	72.5	93.9	72.5	103.9	6.0	1.02
Linseed meal, oil < 5%	92.3	64.0	91.1	65.0	104.0	3.0	1.02
Linseed meal, oil > 5%	93.0	67.9	91.9	68.6	103.7	3.0	1.02
Linseed, full fat	96.4	79.1	95.6	79.1	102.9	3.0	1.02
Linseed, full fat, extruded	96.4	79.1	95.6	79.1	102.9	3.0	1.02
Liquid potato feed	95.9	73.2	94.5	74.4	101.4	3.0	1.03
L-Lysine HCL	90.9	77.9	90.8	77.9	100.0	0.0	1.00
L-Threonine	91.6	77.7	91.5	77.8	100.0	0.0	1.00
L-Tryptophan	94.0	77.3	93.9	77.3	100.0	0.0	1.00
Lupin, blue	92.9	63.4	91.4	64.8	107.4	6.0	1.03
Lupin, white	93.3	65.9	92.1	66.8	106.0	6.0	1.02
Lupin, white, extruded	93.3	65.8	92.1	66.7	105.7	6.0	1.02
L-Valine	94.0	77.3	94.1	77.3	100.0	0.0	1.00
Maize	97.6	80.1	97.1	79.6	104.1	7.0	1.03
Maize bran	96.3	74.3	94.8	73.8	117.1	7.0	1.06
Maize distillers grains with solubles, oil < 6 %, dried	93.8	65.3	92.0	67.1	111.5	7.0	1.04
Maize distillers grains with solubles, oil > 6%, dried	94.3	68.6	92.7	69.8	110.2	7.0	1.03

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- b (unitless): $OMdg = b \times Edg$

Name	Growing Adult		Adult		DEa/DE g	DEg → DEa	
	ME/D	NE/M	ME/D	NE/M		a	b
Maize feed flour	97.2	78.3	96.4	77.8	107.7	7.0	1.0
Maize flour, crude fibre < 2%	97.7	79.2	97.2	79.4	101.5	7.0	1.0
Maize germ meal, oil < 5%	93.8	66.6	92.2	67.6	105.8	3.0	1.0
Maize germ meal, oil 5-20%	94.5	70.6	93.3	71.2	105.2	3.0	1.0
Maize germs, oil > 30%	97.6	88.0	97.0	86.4	104.9	3.0	1.0
Maize germs, oil 14-30%	97.0	80.8	96.2	79.6	109.4	7.0	1.0
Maize processing by-product, protein 8-18%, oil <	95.8	73.1	94.5	72.5	116.1	7.0	1.0
Maize processing by-product, protein 8-18%, oil 5-14%	96.5	77.0	95.5	76.2	110.6	7.0	1.0
Maize starch	98.8	81.8	98.5	82.0	100.0	0.0	1.0
Maize starch by-product	95.5	73.3	93.8	71.9	129.4	7.0	1.0
Maize, extruded	97.6	80.6	97.2	79.9	103.7	7.0	1.0
Maize, flaked	97.6	80.6	97.2	79.9	103.7	7.0	1.0
Maize, high moisture	97.6	80.0	97.1	79.5	104.1	7.0	1.0
Mealworm larvae, dehydrated	94.2	74.6	93.9	74.8	100.0	0.0	1.0
Meat and bone meal, fat < 7.5 %	89.8	63.2	89.6	62.5	100.0	0.0	1.0
Meat and bone meal, fat > 7.5 %	90.8	68.1	90.6	67.2	100.0	0.0	1.0
Methionine Hydroxy Analogue MHA, 80% efficiency	94.9	77.1	94.8	77.1	100.0	0.0	1.0
Milk powder, skimmed	94.2	72.7	94.0	72.7	100.0	0.0	1.0
Milk powder, whole	96.4	78.6	96.3	78.8	100.0	0.0	1.0
Millet, common	97.1	78.9	96.9	78.0	103.8	3.0	1.0
Millet, pearl	97.1	79.2	96.8	78.8	102.8	3.0	1.0
Molasses, beet	97.2	68.7	97.0	68.8	103.0	3.0	1.0
Molasses, sugarcane	98.0	69.8	97.8	70.2	103.0	3.0	1.0
Mustard bran	95.3	72.2	93.6	71.5	110.3	3.5	1.0
Oat groats	96.6	76.7	96.1	76.9	102.1	2.5	1.0
Oat hulls	94.3	63.0	91.8	63.1	119.6	2.5	1.1
Oats	96.3	75.1	95.3	74.8	105.9	2.5	1.0
Oats, flaked	96.3	76.1	95.4	75.4	105.6	2.5	1.0
Olive oil cake, with pits, oil < 5%	93.1	51.0	90.2	53.2	122.7	3.0	1.1
Olive oil cake, with pits, oil > 5%	94.6	65.5	92.1	64.7	117.6	3.0	1.1
Olive pulp, oil < 10%	93.4	60.8	90.7	62.9	113.6	3.0	1.0
Olive pulp, oil > 10%	96.6	83.8	95.4	81.6	108.1	3.0	1.0
Palm kernel meal, oil < 5%	93.1	58.9	90.4	61.7	108.4	3.0	1.0
Palm kernel meal, oil 5-20%	93.9	63.7	91.5	65.6	108.0	3.0	1.0
Palm oil	99.4	89.6	99.4	89.4	100.0	0.0	1.0
Pea	95.4	73.3	94.7	73.2	103.8	6.0	1.0

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Name	Growing Adult		Adult		DEa/DEg	DEg → DEa	
	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Pea bran, starch industry by-product	94.3	58.8	91.1	60.3	107.8	6.0	1.07
Pea cream	94.8	67.2	94.0	67.4	102.4	6.0	1.02
Pea protein concentrate	90.3	56.5	90.0	56.7	100.5	6.0	1.00
Pea pulp, starch industry by-product	96.5	72.3	95.0	72.8	103.0	6.0	1.02
Pea solubles, starch industry by-product	93.6	63.7	93.3	63.8	101.9	6.0	1.01
Pea, extruded	95.4	73.1	94.7	73.1	103.4	6.0	1.02
Potato protein concentrate	89.2	59.6	88.8	60.1	100.8	3.0	1.01
Potato pulp, dried	96.6	72.4	95.0	72.6	105.4	3.0	1.05
Potato tuber, dried	97.7	78.6	97.4	78.4	101.4	3.0	1.01
Poultry fat	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Processed animal proteins, pig	91.2	68.9	91.0	68.1	100.0	0.0	1.02
Processed animal proteins, poultry, protein > 70%	90.6	64.8	90.5	64.7	100.0	0.0	0.99
Processed animal proteins, poultry, protein 45-60%	93.4	74.5	93.3	74.2	100.0	0.0	1.01
Processed animal proteins, poultry, protein 60-70%	92.2	70.7	92.1	70.3	100.0	0.0	1.01
Rapeseed meal, oil < 5%	92.2	61.5	91.1	62.2	107.1	3.5	1.04
Rapeseed meal, oil 5-20%	93.7	69.1	92.9	69.2	105.8	3.5	1.03
Rapeseed oil	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Rapeseed, full fat	97.2	79.8	96.7	80.1	102.3	3.0	0.99
Rapeseed, full fat, extruded	97.2	79.8	96.7	80.1	102.3	3.0	0.99
Rice bran, oil < 5%, crude fibre > 20%	95.3	62.4	93.0	62.5	117.5	3.0	1.12
Rice bran, oil < 5%, crude fibre 11-20%	95.2	66.4	93.6	67.3	107.1	3.0	1.06
Rice bran, oil < 5%, crude fibre 5-11%	95.6	69.9	94.3	70.8	105.3	3.0	1.05
Rice bran, oil > 5%, crude fibre > 20%	95.9	67.8	93.8	67.4	113.1	3.0	1.09
Rice bran, oil > 5%, crude fibre 11-20%	96.6	75.6	95.4	75.3	106.4	3.0	1.05
Rice bran, oil > 5%, crude fibre 5-11%	96.4	76.5	95.4	76.8	104.3	3.0	1.04
Rice hulls	93.1	51.2	90.1	53.3	133.5	3.5	1.17
Rice shorts, oil < 5%, crude fibre < 5%	96.9	76.7	96.3	77.0	103.0	3.0	1.03
Rice shorts, oil > 5%, crude fibre < 5%	96.7	77.4	96.0	77.7	103.2	3.0	1.03
Rice, brown	97.5	82.5	97.4	81.7	100.3	3.0	1.06
Rice, paddy	97.6	78.5	97.3	77.4	104.5	3.0	1.04
Rice, polished, broken	97.7	81.1	97.5	80.8	100.4	3.0	1.04
Rye	97.0	77.0	96.2	77.5	102.2	3.0	1.03
Sesame meal, oil > 5%	92.1	66.9	91.4	67.3	103.5	3.0	1.02
Sheanut oil meal, oil > 5%	94.2	69.0	91.8	71.0	108.3	3.5	1.05
Shrimp meal	90.6	60.5	90.4	60.0	100.0	0.0	1.03
Sorghum	97.5	78.9	97.1	78.9	101.8	3.0	1.03

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Name	Growing Adult		Adult		DEa/DEg	DEg → DEa	
	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Soybean hulls	93.6	55.3	91.0	58.6	137.9	8.0	1.06
Soybean meal, oil < 5%, 46% protein + oil	91.7	62.0	90.9	63.0	106.5	8.0	1.01
Soybean meal, oil < 5%, 48% protein + oil	91.4	61.4	90.6	62.5	106.3	8.0	1.01
Soybean meal, oil < 5%, 48% protein + oil, extruded	91.4	61.4	90.6	62.5	106.3	8.0	1.01
Soybean meal, oil < 5%, 50% protein + oil	91.3	62.1	90.7	62.9	105.1	8.0	1.01
Soybean meal, oil 5-20%	92.7	65.8	91.9	66.6	105.7	8.0	1.01
Soybean molasses	97.5	69.6	97.2	69.9	103.2	3.0	1.04
Soybean oil	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Soybean protein concentrate, protein 50-60%	90.8	60.9	89.9	62.2	104.4	8.0	1.00
Soybean protein concentrate, protein 60-70%	90.2	60.3	89.7	61.1	104.4	8.0	1.00
Soybean protein concentrate, protein 70-90%	89.8	59.8	89.6	60.5	103.1	8.0	0.99
Soybean, full fat, extruded	93.9	73.4	93.3	72.7	109.4	8.0	1.02
Soybean, full fat, flaked	93.9	73.4	93.3	72.7	109.4	8.0	1.02
Soybean, full fat, toasted	94.0	74.2	93.6	73.2	109.5	8.0	1.02
Soybean, full fat, toasted, flaked and expanded	94.2	74.5	93.7	73.6	109.4	8.0	1.02
Sunflower hulls	93.6	43.8	91.7	47.9	157.8	3.5	0.88
Sunflower meal, oil < 5%, dehulled	91.2	59.0	90.2	59.4	108.7	3.5	1.04
Sunflower meal, oil < 5%, non dehulled	91.4	56.9	90.2	57.2	114.8	3.5	1.07
Sunflower meal, oil > 5 %, protein > 30%	92.7	66.1	91.8	65.7	108.1	3.5	1.04
Sunflower meal, oil > 5%, protein < 30%	93.8	71.4	92.8	69.5	111.8	3.5	1.06
Sunflower oil	99.4	89.6	99.4	89.4	100.0	0.0	1.00
Sunflower seed, full fat	97.2	84.1	96.6	82.7	104.5	3.0	0.98
Sweet potato, dried	98.0	79.5	97.6	79.5	101.5	3.0	1.03
Tallow	99.4	89.9	99.3	89.7	100.0	0.0	1.00
Tomato pulp, dehydrated	93.8	52.2	91.1	56.2	111.1	3.0	1.08
Triticale	97.0	78.2	96.5	78.1	101.8	2.5	1.03
Vinasse, different origins	90.6	58.9	90.4	58.9	100.0	0.0	1.00
Vinasse, from the production of glutamic acid	90.3	59.1	90.1	58.9	100.0	0.0	1.00
Vinasse, from yeast production, protein 30 %	91.7	60.6	91.5	61.0	100.0	0.0	1.00
Vinasse, from yeast production, protein 40%	90.7	59.6	90.6	59.6	100.0	0.0	1.00
Vinasse, from yeast production, protein 48%	90.4	59.5	90.2	59.4	100.0	0.0	1.00
Wheat bran	94.7	70.4	93.5	70.3	110.4	3.0	1.07
Wheat bran from starch production	94.7	70.0	93.4	70.0	110.1	3.0	1.07
Wheat bran, durum	95.0	72.6	94.0	71.9	110.7	3.0	1.07
Wheat distillers' grains, dark colour, L < 50	93.3	59.7	91.7	60.4	108.7	3.0	1.03
Wheat distillers' grains, light colour, L > 50	92.6	61.3	91.3	61.9	105.6	3.0	1.02

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	ME/DE	NE/ME	ME/DE	NE/ME		a	b
Wheat distillers' grains, starch < 7%, dried	92.6	62.9	91.1	64.5	106.2	3.0	1.04
Wheat distillers' grains, starch > 7%, dried	93.3	64.9	92.0	66.5	104.8	3.0	1.03
Wheat feed flour	96.9	77.1	96.6	77.3	100.9	3.0	1.02
Wheat feed flour, durum	96.7	76.7	96.4	76.8	101.3	3.0	1.02
Wheat feed flour, durum, from semolina	96.5	76.0	96.2	76.3	101.0	3.0	1.02
Wheat gluten	90.4	59.4	90.0	60.3	101.9	3.0	0.99
Wheat gluten feed, type 20% starch	94.6	68.4	93.0	69.9	105.5	3.0	1.04
Wheat gluten feed, type 30% starch	95.6	71.3	94.6	72.0	105.3	3.0	1.04
Wheat middlings, all types except durum	95.4	72.7	94.5	72.6	106.7	3.0	1.05
Wheat middlings, durum	95.6	73.8	94.8	73.4	106.8	3.0	1.05
Wheat middlings, starch < 20%	94.8	69.7	93.4	70.5	107.0	3.0	1.05
Wheat middlings, starch > 40%	96.4	76.4	96.0	75.6	105.2	3.0	1.04
Wheat middlings, starch 20-30%	95.2	71.8	94.2	72.0	106.8	3.0	1.05
Wheat middlings, starch 30-40%	95.8	73.6	94.9	73.5	105.5	3.0	1.04
Wheat straw	90.8	42.1	89.1	45.6	144.6	1.5	0.80
Wheat, durum	96.5	76.9	96.0	76.7	102.2	3.0	1.03
Wheat, soft	96.9	78.1	96.5	78.0	102.0	3.0	1.03
Whey permeate, dehydrated	97.9	85.4	97.7	84.3	100.0	0.0	1.02
Whey powder, acid	97.3	80.7	97.1	80.2	100.0	0.0	1.02
Whey powder, sweet	97.0	80.4	96.9	79.9	100.0	0.0	1.02
Whey, dehydrated, with added fat 15-30%	97.3	81.5	97.2	81.2	100.0	0.0	1.05
Whey, dehydrated, with added fat 4-15%	96.9	79.1	96.7	78.9	100.0	0.0	1.04

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