MTT REPORT 164

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Tables of composition and nutritional value of organically produced feeds materials for pigs and poultry

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Abstract

Organically produced cereals, legumes, oil seed products, forages, silages and new protein feedstuffs were analysed for nutrient composition. In this report, new high quality, protein rich feedstuffs included microalgae, insects and mussel meal. Protein feedstuffs also contained samples from less known plant feed materials for pigs and poultry, such as sainfoin seeds with hulls or dehulled, grass pea seeds and soybean by-product okara.

Feed samples were analysed for dry matter, ash, crude protein, ether extract, crude fibre, neutral and acid detergent fibre, lignin, starch, sugars, amino acids, minerals, phytic acid, phytase activity and *in vitro* digestibilities according to Boisen and Fernàndez (1995, 1997) to predict the standardised ileal digestibility of amino acids (Boisen 2007). MTT, Agrifood Research Finland, analysed all the feed ingredients that were used in the feeding experiments throughout the ICOPP project. By having all samples analysed in the same place, and using the same methodology, it is possible to compare feed ingredients and transfer the results from country to country.

Furthermore, there is often lack of information concerning analysed nutrient composition of organically produced feed materials. Information in this report can be used in feed optimisation for pigs and poultry on farms and by feed manufactures. Feedstuff names have been compiled based on EU feed catalogue (EU 575/2011).

The calculation of feed energy values for pigs and poultry differs between European countries. In this report, the nutrient contents are translated into the feeding values according to feed evaluation systems used in different European countries. This report contains energy and protein values for pigs based on the French, Dutch and Danish feed evaluation systems. Energy values of feeds were also calculated according the British, German and Swiss feed evaluation systems. Energy values for poultry were presented according to the Finnish and Dutch feed evaluation systems.

Keywords

feed evaluation, organic production, feed materials, chemical composition, energy, protein, amino acids, pigs, poultry

Luonnonmukaisesti tuotettujen rehuaineiden kemiallinen koostumus ja ruokinnallinen arvo sioilla ja siipikarjalla

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Tiivistelmä

Raportin tavoitteena on tuottaa tietoa luonnonmukaisesti tuotetuista rehuraaka-aineista sikojen ja siipikarjan ruokinnassa. Luonnonmukaisesti tuotetuista viljoista, palkokasveista, öljykasvien siemenistä, säilörehusta ja uusista rehuaineista analysoitiin kemiallinen koostumus. Uudet rehuaineet ovat tässä raportissa esparsetti, peltonätkelmä, soijapulppa (okara) sekä levät, hyönteiset ja simpukat.

Näytteistä analysoitiin kuiva-aine, tuhka, raakavalkuainen, raakarasva, raakakuitu, NDF, ADF, ligniini, tärkkelys, sokerit, aminohappokoostumus, kivennäiskoostumus, fytiinihappo ja fytaasiaktiivisuus. *In vitro*- sulavuudet määritettiin Boisenin ja Fernàndezin (1995, 1997) mukaan. Standardoidut aminohappojen ohutsuolisulavuudet määritettin Boisenin (2007) mukaisesti. Kaikki rehuaineet analysoitiin Maa- ja elintarviketalouden tutkimuskeskuksen (MTT) laboratoriossa. Analyysitulosten vertailu eri maiden kesken helpottuu, kun kaikki analyysit on tehty samassa paikassa samoin menetelmin. Rehuaineluettelo on koottu ICOPP- projektiin kuuluneista tutkimuksista. Raportin rehuaineet on luokiteltu ja numeroitu EU:n rehuaineluettelon mukaisesti.

Luonnonmukaisesti tuotetuista rehuraaka-aineista on usein puutteellisesti analyysitietoja tai joudutaan khuraaka-aineista on usei viljeltyjen rehuaineiden koostumustietoja. Raportin analyysitietoja voidaan kaaka-aineista on usein puutteellisesti analyysitietoja tai joudutaan khuraaka-ain

Sikojen ja siipikarjan rehujen rehuarvojen laskentaperusteet vaihtelevat huomattavasti Euroopan eri maissa. Tähän raporttiin on koottu rehuluettelon mukaiset rehujen rehuarvot laskettuina eri maiden rehuarvojärjestelmillä. Sikojen energia- ja valkuaisarvot on ilmoitettu Ranskan, Hollannin ja Tanskan laskentaperusteiden mukaan. Lisäksi energia-arvot sioille on laskettu Englannin, Saksan ja Sveitsin energia-arvojärjestelmien mukaisesti. Siipikarjan energia-arvot ilmoitetaan raportissa Suomen ja Hollannin järjestelmän mukaan laskettuna.

Keywords:
rehuarvo, luonnonmukainen tuotanto, rehuaineet, kemiallinen koostumus, energia, valkuainen, siat, siipikarja

Table of contents

1 Introduction

The main aim of this feed table is to increase knowledge of organically produced feed materials for pigs and poultry. It is crucial to present reliable feed values as a base for feed formulation. Different phases of production require knowledge of energy values and nutrient composition to achieve high production results as well as good animal health and welfare. The cost of feeds in organic pig and poultry production is approximately 60 to 70 % of the total production costs. In order to attain economically favourable outcomes, there is an obvious need to gather exact nutritional data as much as possible.

In addition, an important target for this work was to study novel and innovative feed materials for pig and poultry production. Useful information has been obtained about the nutrient composition of potential novel protein feedstuffs for organic pig and poultry production such as grass pea seeds, sainfoin seeds (whole and dehulled), soybean by-product okara, microalgae, mussel meal and *Hermetia illucens* larvae and meals. *Hermetia illucens* larvae and meals are not yet permitted for use in pig and poultry nutrition. However, they are potential high quality protein sources for feeding of monogastric domestic animals in the future.

The potential of legumes such as sainfoin, grass pea and sweet lupin seeds for organic pig and poultry production has not been fully explored to date. Because they are not as common feed materials in conventional production as peas and faba beans, there has been lack of published analyses of their chemical composition and feeding values. The same issue concerns some by-products of organic food processing. Okara, a soybean by-product from the production of beancurd (tofu), is a potential high quality protein source for organic production.

One purpose of this work was to analyse different roughages for pigs and poultry. In organic production, pigs should be fed roughages daily. However, the contribution of roughages to the nutrient supply of pigs and poultry is not exploited efficiently. A good source of information could encourage farmers to extend silage use to organic pig and poultry feeding.

2 Material and methods

2.1 Chemical analyses of organic feedstuffs

2.1.1 Feed materials

Feed numbers and names are expressed as in EU Catalogue of feed materials (EU 575/2011).

The chemical composition values have been collected from feed sample data of ICOPP partners. The feed materials described in the tables are those which have been used in ICOPP experiments. Feed materials have been collected from following ICOPP partners:

- Wageningen UR Livestock Research, The Netherlands
- ORC, Organic Research Centre, United Kingdom
- Swedish University of Agricultural Sciences, Sweden
- BOKU-University of Natural Resources and Life Sciences Vienna,Austria
- Institute of Organic Farming, Germany
- MTT, Agrifood Research Finland, Finland
- University of Applied Sciences Weihenstephan-Triesdor, Germany
- Louis Bolk Institute, The Netherlands
- Food Animal Initiative, United Kingdom
- Research Institute of Organic Agriculture (FiBL), Switzerland

The country of ICOPP partner and the origin of feed sample is given in the tables s follows: FI = Finland, SE= Sweden, UK= United Kingdom, AT= Austria, NL= Netherlands, DE= Germany, CH= Switzerland

If several samples from same feed material and year were analysed, the average was calculated for those samples. In that case, number of samples (n) and the CV, coefficient of variation %(n=3 or more) or min – max values (n=2) of those samples is also given. If more than one analysis in one year, samples are from different batches of mentioned feed material.

2.1.2 Methods of analysis

The chemical composition of feed materials were analysed in the laboratory of MTT Animal Production Research. It is a testing laboratory (T024) accredited by FINAS and its quality system conforms to the requirements of the following Standard: SFS-EN ISO/IEC 17025.

Feed analyses of proximate composition included dry matter, ash, crude protein (N*6.25), ether exctract (after acid hydrolysis), crude fibre, neutral and acid detergent fibre, lignin, starch and sugars. Amino acid analysis included all amino acids except tryptophan. Mineral analysis included Ca, P, K, Na, Mg, Mn, Fe, Cu, Zn, S and Se. Phytic acid analysis and intrinsic phytase activity were also determined. *In vitro* digestibilities for pigs included the digestibility of N and DM for the estimation of standardised ileal digestibility (SID) of amino acids and the digestibility of OM for the estimation of total tract digestibility of energy.

All values are expressed per kg dry matter.

References to the principal methods used in the chemical analyses and *in vitro* digestibilities are given below.

Dry matter (DM)

DM content was determined by drying samples at 105°C for 20 h.

Ash

Ashing at 600°C for 2 h or alternatively at 510°C for 16 h. Official method AOAC-942.05 (Association of Official Analytical Chemists, USA).

Ether extract (crude fat) after acid hydrolysis (EE)

Acid hydrolysis with 3 M HCl and ether extraction according to the accredited in-house methods No. 4.21 and 4.22 by Soxcap-Soxtec-Analyzer. Official Method AOAC-920.39 (Association of Official Analytical Chemists, USA) Fat (Crude) or Ether Extract in Animal Feed and Foss Tecator Application Note AN 390).

Nitrogen (Crude protein) by Kjeldahl method

Accredited in-house methods 1120, 1122 and 1125 Kjeldahl; Official method AOAC-984.13 (Association of Official Analytical Chemists, USA) using Cu as a digestion catalyst and using Foss Kjeltec 2400 Analyzer Unit (Foss Tecator AB, Höganäs, Sweden). Crude protein value was achieved by multiplying the nitrogen content by correction factor 6.25.

Crude fibre

by Fibertec 2023 FiberCap system (Foss Tecator AB, Höganäs, Sweden). EEC 92/89, ASN 3802. The determination of crude fibre in feed according to EEC standard using the FiberCap 2021/2023 system.

Neutral detergent fibre (NDF)

NDF Method (Method 6) : Neutral Detergent Fiber in Feeds - Filter Bag Technique (for A200 and A200I) using 25 microns nylon bags (F57, ANKOM Technology) and ANKOM 220 Fiber Analyzer (ANKOM Technology, 2052 O'Neil Road, Macedon NY 14502). Detergent solution was made according to Van Soest, P.J., Robertson, J.B. and Lewis, B.A. 1991. Methods for dietary fibre, neutral detergent fibre and nonstarch polysaccharides in relation to animal nutrition. Journal of Dairy Science, 74: 3583-3597. Sodium sulfite was used in NDF-detergent solution and α-amylase in case of samples containing starch. NDF is expressed without containing residual ash.

Acid Detergent fibre (ADF)

ADF Method (Method 5) : Acid Detergent Fiber in Feeds - Filter Bag Technique (for A200 and A200I) using 25 microns nylon bags (F57, ANKOM Technology) and ANKOM 220 Fiber Analyzer (ANKOM Technology, 2052 O'Neil Road, Macedon NY 14502). Detergent solution was made according to Robertson, J.B. and Van Soest, P.J. 1981. The detergent system of analysis and its application to human foods. In: James, W.D.T. and Theander, O. (eds.). The Analyses of dietary Fibre in Foods. New York, NY, Marcell Dekker. p. 123-158.

Acid Detergent Lignin (ADL)

In-house method 4.18, determination by Fibertec System M Analyzer based on Ordior Application Note AN 304 and Ordior Application Sub Note ASN 3430 (AOAC- Method 973.18. Official Methods of Analysis. Association of Official Analytical Chemists).

Starch

by Salo, M-L. and Salmi, M. 1968. Determination of starch by the amyloglucosidase method. Jounal of the Scientific Agricultural Society of Finland, 40: 38-45.

Water soluble carbohydrates (reducing sugars)

Somogyi, M. 1945. A new reagent for the determination of sugars. Journal of Biological Chemistry 160: 61-68

Amino acids

In-house method No. 5000: Determination of amino acids (UPLC). European Commission (1998). Commission Directive 98/64/EC. Community Methods of Analysis for the determination of amino acids, crude oils and fats, and olaquindox in feeding stuffs and amending Directive 71/393/EEC. Official Journal L 257, 19/09/1998 p. 14-28. Total (peptide bound and free) amino acid analysis was performed Waters Finland MassTrak UPLC (Waters Corporation, Milford, U.S.A) and the application was UPLC Amino Acid Analysis Solution®.

In vitro standardised ileal digestibility of N and dry matter

by Boisen, S. and Fernàndez, J.A. 1995. Prediction of the apparent ileal digestibility of protein and amino acids in feedstuffs and feed mixtures for pigs by *in vitro* analyses. Animal Feed Science and Technology, 51: 29-34.

Calculation of standardised ileal digestibility af amino acids

by Boisen S. 2007. *In vitro* analyses for predicting standardised ileal digestibility of protein and amino acids in actual batches of feedstuffs and diets for pigs. Livestock Science 109, 182 – 185.

In vitro (pigs), total tract digestibility of organic matter

by Boisen, S. and Fernàndez, J.A. 1997. Prediction of the total tract digestibility of energy in feedstuffs and in pig diets by *in vitro* analyses. Animal Feed Science and Technology, 68: 277-286.

Minerals and trace elements (Ca, P, K, Na, Mg, Mn, Fe, Cu, Zn, S)

by Luh Huang, C.-Y. and Schulte, E.E.. 1985. Digestion of plant tissue for analysis by ICP emission spectrometry. Communications in soil science and plant analysis 16: 943-958. Measurement was performed with ICP-OES (Thermo Jarrel Ash Iris Advantage, Franklin, USA).

Selenium

by Kumpulainen et al. 1983. Eletrothermal Atomic absorption Spectrometric Determination of Selenium in Foods and Diets J.Assoc. Anal. Chem. 66(5): 1129–1135.

Phytase activity

by International standard ISO 30024:2009. Animal feeding stuffs – Determination of phytase activity.

Phytic acid

by Plaami, S. & Kumpulainen, J. 1991. Determination of phytic acid cereals using ICP-OES (Thermo Jarrel Ash Iris Advantage, Franklin, USA) to determine phosphorus. Journal Association of Official Analytical Chemistry, 74: 32-36.

2.2 Calculation of feeding values of organic feedstuffs

2.2.1 Energy and protein values for pigs

Energy and protein values for organically produced cereals, protein feed ingredients, roughages and new feed materials were calculated by several energy evaluation systems based on analysed chemical composition and amino acid composition. In the case of French, Dutch and Danish feed evaluation system, the reference feed ingredient mentioned in the tables, express the origin of digestibility values for that feed ingredient. Evaluation of energy content of pig feed ingredients is based on their digestible (DE), metabolizable (ME) or net (NE) energy contents. The hierarchy between different feed ingredients is depended on used energy evaluation.

2.2.1.1 The French feed evaluation system

Energy and protein values are based on INRA-AFZ-AJINOMOTO EUROLYSINE S.A.S. 2004. Energy and protein values are calculated using EvaPig®-calculator (version 1.3.1.7). It provides digestible (DE), metabolizable (ME) and net energy (NE) values for both growing pigs (from weaning up to 150 kg) and for adult pigs (adult sows, boars).

EvaPig® provides values for standardised ileal digestible amino acids. In this report the values for ileal standardised digestible lysine, threonine, methionine, cysteine and valine are expressed as g/kg DM. Calculations of all feed materials are based on reference values of EvaPig® ingredients. Reference feed ingredient is derived from the closest reference ingredient from a biological point of view. If available in other feed evaluation systems, same reference feed ingredient has been used.

EvaPig® manual of equations and coefficients will be found
http://www.evapig.com/IMG/pdf/EvaPigManualEquations-3.pdf.

INRA- AFZ based energy evaluation system is used in France, Sweden and Finland.

2.2.1.2 The Dutch feed evaluation system

Energy and protein values based on Dutch CVB Feed table are calculated using Feed Value Calculator (CVB 2007). It provides net energy value, NEv (= net energy value for fat accretion) for calculated feed materials. The energy value of the feed ingredient is also expressed as EW (1NEv = 8.8 MJ NE).

Protein values are calculated as standardised digestible lysine, threonine, methionine, cysteine and valine. The reference feed ingredient has been chosen as close as possible from a biological point of view as in the case of Evapig®-calculation.

Calculation basis, equations and coefficients will be found in CVB Feed Table (CVB 2011).

The Dutch energy system is used in The Netherlands, Norway and Poland.

2.2.1.3 The Danish feed evaluation system

The Danish energy evaluation system (Potential Physiological Energy system, PPE) is based on the theoretical biochemical utilization of energy by pigs. The Danish energy evaluation system based energy values are expressed as Feed units for growing pigs (1 FEsv = 7.38 MJ physiological energy) and sows (1 FEso = 7.70 MJ physiological energy).

Protein values are calculated as standardised digestible lysine, threonine, methionine, cysteine and valine. *In vitro* digestibilities at ileal and faecal level for feed materials in this report, have been taken from reference feed ingredient as published in the Danish feed table. Also the standardised ileal digestibilities of individual amino acids are calculated as in reference feed ingredient.

Calculation basis and equations for Danish feed evaluation system (Boisen 2006) are found in http://vsp.lf.dk/~/media/Files/PDF%20-%20Publikationer/Rapporter/Rapport30_DSP_Fodervurderingssystem_Svinefoder.ashx.

2.2.1.4 *In vitro* digestibilities

In this report standardised digestibility of crude protein (SDCP, %) and amino acids (SDAA, %) in feed materials were calculated from *in vitro* analyses of enzyme digestibility of crude protein and enzyme indigestible dry matter (Boisen 2007).

2.2.1.5 The British feed energy evaluation system

The British energy system is based on the work of the French INRA laboratories. Energy values for feed materials are expressed in net energy (NE). Digestible energy (DE) is also expressed in the tables for comparison. Energy digestibilities (ES, %) for growing pigs in this report have taken from Sauvant et. 2004 (marked in table as a reference feed ingredient).

Calculation basis for the British energy evaluation system will be found in a publication by the British Society of Animal Science; Nutrient Requirement Standards for Pigs and in Premier Atlas Ingredients matrix, 2010 (http://www.premiernutrition.co.uk/default.aspx?SectionID=UK_TecAt).

2.2.1.6. The German feed energy evaluation system

The German feed evaluation system for pigs is based on metabolizable energy (ME). Due to missing digestibility values, the energy values for roughages were not possible to count. Calculation basis for German feed evaluation system can be found in http://www.gfe-frankfurt.de/download/ME-Schaetzung.pdf (GfE, 2008).

2.2.1.7. The Swiss feed energy evaluation system

The Swiss Energy system is based on digestible energy (DE). Two different equations are used, depending on crude protein content in feed materials. Due to restricted regression demands for crude protein, crude fat and crude fiber, energy values for all feed materials were not possible to calculate.

Calculation basis and exact equations for Swiss feed evaluation system will be found in http://www.admin.ch/opc/de/classified-compilation/20092465/201407010000/916.307.1.pdf.

2.3 Energy and protein values for poultry

In this report, the energy values for poultry have been calculated using two different evaluation systems, the Finnish and Dutch system. The protein values for poultry have been calculated using the Dutch feed evaluation system.

2.2.2.1 The Finnish feed evaluation system

The Finnish energy value of feed ingredients for poultry is expressed as megajoules (MJ) of metabolizable energy (ME). The values are calculated based on a method presented either by WPSA (1986) or by equation based on digestible nutrients.

More information about Finnish energy system for poultry can be found https://portal.mtt.fi/portal/page/portal/Rehutaulukot/feed_tables_english/feed_tables/basis_of_calculations/energy_value_poultry.

2.2.2.2 The Dutch feed evaluation system

Energy and protein values based on CVB Feed table are calculated using Feed Value Calculator (CVB 2007). Energy values for poultry are expressed as metabolizable energy (ME). System calculates energy values separately for adult animals (adult cocks and laying hens) and for broilers. Amino acids values are calculated as faecal digestible amino acids, g/kg DM. The reference feed ingredient has been chosen as close as possible from a biological point of view. Calculation basis, equations and coefficients are found in CVB Feed Table 2011.

2.4 List of abbreviations used in chemical composition tables

	unit	description		unit	description
ADF	g	acid detergent fiber	**kg**		kilogram
ADF-N	g	nitrogen in acid detergent fiber	**Leu**	g	leucine
ADL	g	acid detergent lignin	**Lys**	g	lysine
Ala	g	alanine	**Met**	g	methionine
Arg	g	arginine	**mg**		milligram
Ash	g	crude ash	**Mg**	g	Magnesium
Asp	g	aspartic acid	**Mn**	mg	Manganese
Ca	g	Calcium	**Na**	g	Sodium
CF	g	crude fibre	**NDF**	g	neutral detergent fiber
CP	g	crude protein	**P**	g	Phosphorus
Cu	mg	Copper	**Phe**	g	phenylalanine
Cys	g	cystine	**Pro**	g	proline
DM		dry matter	**S**	g	Sulphur
EE	g	crude fat after acid hydrolysis	**Se**	mg	Selenium
Fe	g	Iron	**STA**	g	starch
g		gram	**SUG**	g	sugars
Glu	g	glutamic acid	**Thr**	g	threonine
Gly	g	glycine	**Tyr**	g	tyrosine
His	g	histidine	**Val**	g	valine
Ile	g	isoleucine	**Zn**	mg	Zinc
K	g	Potassium			

2.5 List of abbreviations used in feed evaluation tables

	unit	description
dDM	%	Digestibility of dry matter
DE	MJ	Digestible energy
dig Cys	g	faecal digestible cystine
dig Lys	g	faecal digestible lysine
dig Met	g	faecal digestible methionine
dN	%	digestibility of Nitrogen
dOM	%	digestibility of Organic matter
ED	%	Digestibility of energy
EW		Energy value for pigs
FEso		Feed units for sows
FEsv		Feed units for growing pigs
ME	MJ	Metabolizable energy
MJ		Megajoule
NE	MJ	Net energy
NEv	MJ	Net energy value for fat accretion in pigs
SIDCP	%	standardized ileal digestibility of crude protein
SID Cys	g	standardised ileal digestible cystine
SID Lys	g	standardised ileal digestible lysine
SID Met	g	standardised ileal digestible methionine
SIDThr	g	standardised ileal digestible threonine
SIDVal	g	standardised ileal digestible valine

3 Results

3.1 Chemical composition of organic feed ingredients

Table 1. Chemical composition of organically produced cereals and protein feed ingredients.

no	Name	%	g/kg DM							
		DM	Ash	CP	EE	CF	STA	SUG	NDF	ADF	ADL
1.1.1	Barley FI 2011	85.9	30	112	21	53	670	33	223	63	10
1.11.1	Wheat FI 2011	88.1	22	137	23	31	707	37	141	32	0
1.4.1	Oats FI 2011	86.5	34	117	63	88	564	21	271	100	21
2.14.2	Rape seed meal UK 2012	91.6	66	377	96	118		92	312	182	51
2.14.2	Rape seed, expeller FI 2012	90.7	70	340	163	105		99	249	160	43
2.18.8	Soya bean pulp FI 2011	19.9	38	352	157	146	11	129	295	172	
2.8.1	Linseed UK 2012	89.6	51	384	128	72	21	42	198	97	31
3.11.1	Peas FI 2012	83.7	35	224	24	43	601	65	124	51	0
3.11.1	Peas UK 2012	85.4	30	170	24	71	462	59	153	66	0
3.13.1	Grass pea AT 2011	89.0	31	296	19	68	491	48	244	77	2
	(n=2) min-max	86.8-91.1	30-32	295-297	17-21	65-70			204-285	76-79	
3.15.1	Sainfoin AT 2011	93.4	51	312	69	190	111	80	344	205	29
3.15.1	Sainfoin, dehulled AT 2011	90.6	42	405	82	75	163	102	155	75	3
	(n=3) CV %	2.4	4.5	3.1	7.3	6.2	5.2	6.7	3.7	2.2	141.4
3.7.1	Faba beans UK 2012	84.9	32	277	24	87	397	48	158	92	0
3.7.1	Faba beans FI 2011	83.5	45	320	17	82	456	45	144	88	0
3.9.1	Sweet lupins UK 2012	85.8	40	362	62	147	27	64	244	171	6
4.8.1	Potato, raw FI 2011	18.6	57	76	8	23	563	164	60	31	7
4.8.2	Potato, cooked FI 2011	18.9	58	95							

Table 2. Chemical composition of organically produced roughages.

no	Name	%	g/kg DM							
		DM	Ash	CP	EE	CF	STA	SUG	NDF	ADF	ADL
6.10.1	Lucerne fresh UK 2012	20.4	119	276	47	139		21	212	149	17
6.10.1	Lucerne silage UK 2012	52.1	111	158	50	273		39	445	287	43
6.10.1	Lucerne silage 2nd harvest UK 2012	23.3	127	204	45	297		4	427	304	53
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	26.5	147	250	53	302		1	411	311	71
	(n=2) min-max	25.7-27.3	145-149	246-253							
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	23.1	152	261	50	286		1	391	301	71
6.10.1	Lucerne silage 3rd harvest DE 2012	35.1	136	244							
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	46.8	142	231	38	201		8	329	229	49
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	43.1	131	226	40	216		9	332	241	47
6.10.1	Clover-grass silage DE 2012	27.1	130	137	37	283		53	459	282	
6.10.1	Extruded silage DE 2013	35.8	113	231	41	300			394		
6.10.1	Chopped silage DE 2013	43.4	112	231	45	289			384		
6.10.4	Lucerne pellets UK 2012	90.6	115	167	28	282		55	498	322	66
6.6.3	Grass, wilted and ensiled NL 2011	26.7	130	218	63	219			363	225	19
	(n=3) CV %	11.3	24.8	7.7	9.3	5.1			6.0	7.5	48.3

Table 3. Chemical composition of new feed materials.

no	Name	%	g/kg DM									
		DM	Ash	CP	EE	CF	STA	SUG	NDF	ADF	ADL	ADF-N
7.1.1	*Algae Spirulina* UK 2012	93.6	75	704	75	1	37	5		0	0	14
7.1.1	*Algae Chlorella scenedesmus* NL 2012	93.6	286	396	75	8	12	5	354	111	56	11
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	91.8	124	446	342	*102		8	*191	*88	*18	7
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	92.5	168	627	43	*130		11	*259	*93	*0	10
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	86.5	40	482	396	*112		8	*212	*101	*50	8
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	89.5	60	710	41	*182		12	*325	*199	*29	13
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	88.0	88	405	410	*112		10	*151	*91	*13	7
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	90.3	137	659	20	*172		15	*235	*142	*23	12
10.11.1	Mussel *Mytilus edulis* meal SE 2013	92.9	94	684	105				59	17		
10.11.1	Mussel *Mytilus edulis* meal SE 2012	95.6	96	681	115			8	31	0	0	

MBM = grown on meat and bone meal
CHO = grown on carbohydrate rich material
Kitchen waste = grown on kitchen waste

*Insects contain relatively high amount of fibre as measured by CF, NDF, ADF and ADL, but the components of these fibres are unknown. It has been assumed that most of the fibre in insects is chitin, which represents cellulose structure. ADF fraction from insects contains nitrogen (ADF-N) (Finke 2007).

Because the fibre composition of *Hermetia illucens* meal and larvae and Algae *Chlorella scenedesmus* is different compared to reference feed (fish meal), the feed value of these feed ingredient may be overestimated.

3.2 Amino acid composition of organic feed ingredients

Table 4. Amino acid composition of organically produced cereals and protein feed ingredients.

no	Name	g/ 100 g CP															
		Lys	Thr	Met	Cys	Ile	Val	Leu	Phe	Tyr	His	Arg	Ala	Asp	Glu	Gly	Ser	Pro
1.1.1	Barley FI 2011	3.7	3.4	2.1	2.0	3.5	4.8	6.6	4.5	3.4	2.2	5.2	4.2	6.6	20.4	4.1	3.9	8.8
1.11.1	Wheat FI 2011	2.6	2.8	1.9	2.0	3.4	4.2	6.5	4.3	3.1	2.3	4.8	3.4	5.2	28.9	4.0	4.5	9.3
1.4.1	Oats FI 2011	5.1	3.9	2.2	2.8	4.5	5.7	8.4	5.8	4.1	2.7	8.3	5.4	10.1	21.4	5.4	5.5	5.5
2.14.2	Rape seed meal UK 2012	5.0	4.4	2.1	2.0	3.8	5.1	6.7	3.9	3.1	2.6	5.8	4.2	7.3	16.1	4.8	4.3	6.0
2.14.2	Rape seed, expeller FI 2012	6.3	4.9	2.4	2.1	4.5	5.7	7.7	4.5	3.8	2.9	6.9	5.0	9.1	18.0	5.6	4.7	6.0
2.18.8	Soya bean pulp FI 2011	5.9	3.7	1.5	1.2	4.4	4.6	7.4	4.9	3.4	2.5	7.4	4.2	10.8	16.8	4.3	5.0	4.9
2.8.1	Linseed UK 2012	3.6	3.6	1.9	1.4	4.1	4.9	5.6	4.5	2.5	2.1	9.5	4.3	9.6	19.0	5.6	4.6	3.6
3.11.1	Peas FI 2012	7.8	4.2	1.4	1.7	4.6	5.1	7.8	5.3	4.2	2.7	8.4	4.7	12.6	17.8	4.9	5.4	4.5
3.11.1	Peas UK 2012	7.7	4.2	1.5	1.4	4.2	5.0	7.2	4.9	3.9	2.6	6.9	4.6	11.9	16.8	4.6	5.1	4.1
3.13.1	Grass pea AT 2011	6.4	3.7	1.2	1.6	4.0	4.5	6.6	4.2	3.3	2.7	7.6	4.1	11.2	15.9	4.4	4.9	4.0
	(n=2) min-max	6.3-6-6	3.7-3.7	1.1-1.2	1.5-1.6	3.8-4.2	4.4-4.6	6.4-6.8	4.1-4.4	3.1-3.5	2.6-2.7	7.1-8.1	3.9-4.2	11.1-11.4	15.3-16.5	3.9-4.5	4.8-4.9	4.0-4.1
3.15.1	Sainfoin AT 2011	5.3	3.5	1.8	1.3	3.6	4.2	6.4	3.7	3.2	3.8	10.8	3.7	10.5	17.5	4.7	4.8	4.5
3.15.1	Sainfoin, dehulled AT 2011	5.2	3.4	1.8	1.2	3.5	4.1	6.2	3.6	3.0	3.9	10.8	3.5	10.4	18.1	4.5	4.9	4.4
	(n=3) CV %	3.4	2.9	2.4	9.4	5.5	3.1	4.1	3.5	7.9	3.5	5.5	5.9	2.9	1.8	4.7	2.2	0.7
3.7.1	Faba beans UK 2012	6.7	3.6	1.0	1.0	4.2	4.8	7.2	4.4	3.7	2.6	8.8	4.1	11.9	17.6	4.4	5.1	4.3
3.7.1	Faba beans FI 2011	6.2	3.5	0.9	1.1	4.1	4.6	7.4	4.2	3.7	2.6	10.0	4.0	10.9	16.5	4.2	4.7	4.1
3.9.1	Sweet lupin UK 2012	4.5	3.2	0.7	1.0	3.9	3.7	6.4	3.6	3.5	2.5	10.7	3.2	10.1	20.4	4.0	4.8	3.9
4.8.1	Potato, raw FI 2011	5.9	3.5	2.3	1.3	4.0	6.2	5.4	4.2	4.0	2.3	7.9	3.2	22.7	18.4	3.1	4.9	3.9

Table 5. Amino acid composition of organically produced roughages.

no	Name	g/ 100 g CP																
		Lys	Thr	Met	Cys	Ile	Val	Leu	Phe	Tyr	His	Arg	Ala	Asp	Glu	Gly	Ser	Pro
6.10.1	Lucerne fresh UK 2012	5.7	3.9	2.0	0.7	4.4	5.7	7.6	5.1	3.5	2.2	4.5	5.3	9.9	9.3	4.5	3.5	4.2
6.10.1	Lucerne silage UK 2012	5.0	4.1	1.9	1.0	4.2	5.4	7.2	4.6	3.6	1.9	3.4	5.3	9.6	8.0	4.3	4.0	5.6
6.10.1	Lucerne silage 2nd harvest UK 2012	2.9	3.2	1.5	0.5	3.9	4.9	6.6	4.0	4.5	1.8	1.8	5.2	7.5	5.5	4.2	1.9	4.2
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	2.3	2.1	1.7	0.6	4.3	7.5	6.9	4.1	1.9	1.0	3.0	10.9	4.2	5.1	4.3	2.2	3.2
	(n= 2) min-max	2.2-2.4	1.9-2.2	1.7-1.7	0.5-0.7	4.2-4.4	5.7-9.3	6.8-7.0	4.0-4.3	1.8-2.1	1.0-1.0	3.0-3.0	10.3-11.5	4.0-4.5	4.4-5.8	4.2-4.3	2.0-2.4	2.0-4.5
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	2.0	1.7	1.7	0.5	4.1	9.9	6.6	3.8	1.5	0.9	2.9	11.1	3.6	4.6	4.1	1.8	2.4
6.10.1	Lucerne silage 3rd harvest DE 2012	5.2	4.3	1.6	0.8	4.2	5.5	7.4	4.6	2.6	1.9	2.8	5.4	11.0	9.4	4.9	4.3	5.0
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	5.0	4.1	1.9	0.6	4.2	5.4	6.9	3.7	3.2	1.8	3.1	5.6	10.9	8.8	4.4	4.3	5.1
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	4.9	4.1	1.8	0.7	4.3	5.9	7.0	4.4	2.2	1.9	2.5	5.8	9.5	8.0	4.4	4.3	5.3
6.10.1	Extruded silage DE 2013	2.0	3.7	1.8	0.6	4.2	9.5	6.4	4.1	1.5	0.9	2.6	7.3	10.1	6.7	4.0	2.7	5.2
6.10.1	Chopped silage DE 2013	5.0	4.1	1.8	0.7	4.2	5.5	6.7	4.3	2.8	1.7	1.8	4.9	13.3	7.4	4.0	3.8	5.5
6.10.1	Clover-grass silage DE 2012	4.1	3.4	1.6	0.6	4.1	5.4	7.0	4.0	3.1	1.0	1.7	6.1	8.5	7.0	3.8	3.4	5.7
6.10.4	Lucerne pellets UK 2012	3.8	3.8	1.9	1.0	3.9	4.9	6.4	4.2	2.8	2.0	5.7	4.5	9.9	13.4	5.0	4.2	5.4
6.6.3	Grass, wilted and ensiled NL 2011	4.8	3.9	1.6	0.4	4.1	5.3	7.0	4.2	3.7	1.6	1.5	6.1	10.0	7.9	4.3	3.6	4.4
	(n=3) CV %	2.7	1.6	3.8	10.8	1.1	0.9	1.0	1.4	4.1	5.6	8.4	3.3	2.0	5.1	1.5	0.3	0.9

Table 6. Amino acid composition of new feed materials.

no	Name	g/ 100 g CP																
		Lys	Thr	Met	Cys	Ile	Val	Leu	Phe	Tyr	His	Arg	Ala	Asp	Glu	Gly	Ser	Pro
7.1.1	*Algae Spirulina* UK 2012	4.4	4.6	2.4	1.2	5.2	5.9	8.1	4.1	4.2	1.5	6.7	7.0	9.5	12.8	4.6	4.6	3.5
7.1.1	*Algae Chlorella scenedesmus* NL 2012	5.6	4.9	2.2	1.1	3.7	5.5	7.3	4.6	3.3	1.3	5.3	6.6	10.3	10.8	5.8	4.5	4.7
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	5.1	3.9	2.0	0.5	4.3	6.0	6.9	4.1	5.9	2.8	4.8	5.9	9.4	9.7	5.9	3.9	5.3
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	5.3	3.9	1.9	0.5	4.4	6.2	7.0	4.2	6.3	2.9	4.9	6.0	9.8	10.1	6.1	4.1	5.4
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	4.9	3.7	1.8	0.5	4.2	6.0	6.8	3.8	5.9	2.7	4.5	5.9	8.7	9.1	6.0	3.9	5.4
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	5.1	3.9	1.8	0.5	4.4	6.4	7.1	4.0	6.3	2.9	4.7	6.2	9.2	9.8	6.4	4.2	5.7
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	5.7	4.0	2.0	0.5	4.5	6.3	7.3	4.1	6.9	3.0	5.2	6.3	9.9	10.7	6.5	4.3	5.8
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	5.4	3.9	1.8	0.5	4.3	6.2	6.9	4.1	6.8	3.0	4.9	6.2	9.5	10.5	6.3	4.3	5.7
10.11.1	Mussel *Mytilus edulis* meal SE 2013	7.0	4.5	2.5	1.2	3.9	4.4	6.3	3.4	3.4	1.7	6.6	4.6	9.5	11.8	5.8	4.6	3.8
10.11.1	Mussel *Mytilus edulis* meal SE 2012	7.0	4.3	2.3	1.1	3.9	4.2	6.2	3.4	3.5	1.7	6.6	4.5	9.5	11.4	5.6	4.5	3.6

3.3 Mineral content of organic feed ingredients

Table 7. Mineral content of organically produced cereals and protein feed ingredients.

no	Name	g/kg DM			%	U/kg DM	g/kg DM				mg/kg DM				
		Ca	P	Phytic acid	Phytate P/total P	Phytase	Mg	S	K	Na	Fe	Cu	Zn	Mn	Se
1.1.1	Barley FI 2011	0.4	4.3	11.3	0.74	1261	1.3	1.3	5.7	0.04	66	4.3	37.5	11.9	0.011
1.11.1	Wheat FI 2011	0.3	4.3	11.6	0.76	1449	1.5	1.4	4.8	0.02	42	4.6	36.5	30.0	0.011
1.4.1	Oats FI 2011	0.6	4.3	10.5	0.68	118	1.3	1.5	5.7	0.04	153	5.0	34.3	29.5	0.015
2.14.2	Rape seed meal UK 2012	6.9	8.8	24.2	0.77	41	4.5	7.4	11.1	0.03	196	5.6	57.5	65.9	0.419
2.14.2	Rape seed, expeller FI 2012	7.5	12.8	34.5	0.76	< 0,0	4.9	5.1	12.2	0.06	107	5.8	56.6	39.7	0.035
2.18.8	Soya bean pulp FI 2011	3.3	3.8				1.5	2.6	12.3	0.24	118	11.3	30.8	25.1	
2.8.1	Linseed UK 2012	3.0	6.6	18.0	0.78	< 0,0	4.4	3.7	10.3	0.82	186	19.3	71.9	31.4	0.122
3.11.1	Peas FI 2012	0.6	5.6	11.7	0.58	22	1.3	1.8	11.8	0.02	73	9.1	41.5	5.1	0.012
3.11.1	Peas UK 2012	1.3	4.0	8.9	0.62	118	1.1	1.4	9.5	0.01	32	7.0	30.9	6.4	0.011
3.13.1	Grass pea AT 2011	1.5	3.6	7.0	0.55	12	1.3	2.2	9.2	0.07	101	9.7	43.3	16.1	0.058
3.15.1	Sainfoin AT 2011	7.6	5.5	11.8	0.61	230	1.8	2.6	10.9	0.03	105	8.3	47.4	27.2	0.062
3.15.1	Sainfoin, dehulled AT 2011	1.4	7.3	16.9	0.65	113	1.7	3.3	13.2		77	9.4	61.1	21.1	0.096
	(n=2) min-max	1.3-1.4	7.0-7.6	16.2-17.6	0.65-0.66		1.6-1.8	3.2-3.5	12.8-13.6		73-82	9.2-9.6	59.4-62.7	20.8-21.3	0.089-0.102
3.7.1	Faba beans UK 2012	1.3	4.2	10.0	0.68	17	1.0	1.4	10.7	0.03	50	10.9	36.3	9.5	<0.01
3.7.1	Faba beans FI 2011	1.0	8.0	22.3	0.79	< 0,0	1.5	2.0	13.0	0.04	65	16.9	57.8	11.0	0.012
3.9.1	Sweet lupin UK 2012	3.0	5.3	12.0	0.64	96	1.8	2.7	10.1	0.16	80	6.0	30.8	54.9	0.079
4.8.1	Potato, raw FI 2011		2.47	1.6	0.18		1.06	1.7	23.0	0.03	120	6.8	16.2	6.0	<0.01

Table 8. Mineral content of organically produced roughages.

no	Name	g/kg DM			%	U/kg DM	g/kg DM				mg/kg DM				
		Ca	P	Phytic acid	Phytate P/total P	Phytase	Mg	S	K	Na	Fe	Cu	Zn	Mn	Se
6.10.1	Lucerne fresh UK 2012	22.6	4.2	0.3	0.02	262	2.4	2.2	26.0	0.1	80	9	28	19	0.03
6.10.1	Lucerne silage UK 2012	12.5	4.6	0.8	0.05	38	1.9	2.4	26.8	0.3	146	9	34	30	0.02
6.10.1	Lucerne silage 2nd harvest UK 2012	14.1	4.2	0.1	0.00	165	2.0	2.5	35.2	0.2	315	8	30	19	0.08
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	11.1	3.9	0.1	0.01		2.2	3.3	38.9	0.1	972	10	25	45	
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	12.2	4.5	0.1	0.01		2.5	3.6	41.9	0.1	761	10	24	45	
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	10.6	3.3	0.1	0.01		2.4	2.3	31.7	0.1	1496	9	22	55	
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	10.6	3.4	0.2	0.01		2.4	2.5	33.9	0.1	687	8	19	44	
6.10.1	Clover-grass silage DE 2012	9.1	2.6				2.1	1.6	34.1	0.3	1031	7	30	75	
6.10.4	Lucerne pellets UK 2012	13.1	3.7	7.6	0.57	53	3.0	2.6	16.7	0.6	1417	24	40	68	0.12
6.6.3	Grass, wilted and ensiled NL 2011			0.1		145									0.01

Table 9. Mineral content of new feed materials.

no	Name	g/kg DM						mg/kg DM				
		Ca	P	Mg	S	K	Na	Fe	Cu	Zn	Mn	Se
7.1.1	*Algae Spirulina* UK 2012	1.8	9.6	2.6	6.7	13.8	5.7	920	3.4	16.6	26.4	0.15
7.1.1	*Algae Chlorella scenedesmus* NL 2012	82.7	9.8	2.5	4.2	7.7	6.5	6166	7.9	68.7	906.4	0.12
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	37.1	6.7	2.7	2.9	6.9	0.8	98	9.3	67.2	128.0	
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	52.9	8.9	3.6	4.0	7.7	0.9	172	13.7	95.7	171.7	
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	6.3	5.6	2.3	3.0	7.1	1.3	74	9.5	78.4	162.6	
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	10.1	8.2	3.5	4.6	8.6	1.5	119	14.7	125.9	242.0	
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	24.0	4.8	2.3	2.7	6.5	1.0	156	8.4	69.5	195.4	
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	38.4	6.9	3.5	4.3	8.2	1.3	302	13.3	111.3	319.7	
10.11.1	Mussel *Mytilus edulis* meal SE 2012	3.8	11.3	1.8	10.5	6.4	21.2	340	6.5	138.8	29.4	2.71

3.4 Energy and protein values of organic feed ingredients for pigs

3.4.1 The French feed evaluation system: Energy and protein values

Table 10. Energy values and standardised ileal digestible amino acids of organically produced cereals and protein feed ingredients (EvaPig®).

no	Name	MJ/kg DM						g/kg DM					Reference feed ingredient
		DE grow. pig	ME grow. pig	NE grow. pig	DE adult pig	ME adult pig	NE adult pig	SID Lys	SID Thr	SID Met	SID Cys	SID Val	
1.1.1	Barley FI 2011	14.7	14.2	11.0	15.1	14.5	11.3	3.1	2.8	2.0	1.9	4.3	Barley
1.11.1	Wheat FI 2011	16.0	15.5	12.1	16.3	15.7	12.3	2.9	3.2	2.3	2.5	4.9	Wheat
1.4.1	Oats FI 2011	14.5	14.0	10.7	15.1	14.3	10.9	4.4	3.2	2.2	2.5	5.2	Oats
2.14.2	Rape seed meal UK 2012	14.9	13.7	8.6	15.8	14.2	9.1	14.3	12.3	7.0	6.1	14.7	Rapeseed meal
2.14.2	Rape seed expeller FI 2012	16.6	15.4	10.1	17.4	15.8	10.5	16.0	12.6	7.0	5.8	15.0	Rapeseed meal
2.18.8	Soya bean pulp FI 2011	16.7	15.5	10.6	18.6	17.0	11.7	18.6	11.3	5.0	3.7	14.3	Soyabean meal
2.8.1	Linseed UK 2012	17.9	16.4	10.8	18.3	16.6	11.1	10.7	10.4	6.0	4.1	14.6	Linseed meal, exp. extr.
3.11.1	Peas FI 2012	16.6	15.9	11.9	17.1	16.2	12.1	14.5	7.1	2.5	2.7	8.7	Pea
3.11.1	Peas UK 2012	15.9	15.3	11.3	16.5	15.8	11.7	10.9	5.5	2.0	1.7	6.5	Pea
3.13.1	Grass pea AT 2011	16.3	15.4	11.0	16.6	15.6	11.2	16.7	9.1	2.9	3.5	11.0	Faba bean, white flowers
3.15.1	Sainfoin AT 2011	13.9	13.1	9.1	14.7	13.8	9.5	14.5	9.0	4.7	3.1	10.7	Faba bean, white flowers
3.15.1	Sainfoin, dehulled AT 2011	18.4	17.2	11.8	18.7	17.3	11.9	19.1	11.6	6.15	3.9	13.8	Faba bean, white flowers
3.7.1	Faba beans UK 2012	15.9	15.1	10.8	16.3	15.4	10.9	15.7	8.0	2.2	2.0	10.4	Faba bean, white flowers
3.7.1	Faba beans FI 2011	16.5	15.5	11.0	16.8	15.7	11.1	17.4	9.3	2.4	2.7	12.0	Faba bean, white flowers
3.9.1	Sweet lupin UK 2012	16.2	15.0	9.3	17.6	16.0	10.2	14.1	9.7	2.1	3.1	11.2	Lupin, blue
4.8.1	Potato, raw FI 2011	15.7	15.4	11.9	15.9	15.5	12.0	3.5	2.1	1.5	0.7	3.7	Potato tuber, dehydrated

Table 11. Energy values and ileal standardised ileal digestible amino acids of organically produced roughages (EvaPig®).

		MJ/kg DM						g/kg DM					
no	Name	DE grow. pig	ME grow. pig	NE grow. pig	DE adult pig	ME adult pig	NE adult pig	SID Lys	SID Thr	SID Met	SID Cys	SID Val	Reference feed ingredient
6.10.1	Lucerne fresh UK 2012	12.1	11.1	6.5	12.9	11.6	6.9	10.6	7.5	4.2	0.7	10.9	Alfalfa, dehydr., CP 22-25% DM
6.10.1	Lucerne silage UK 2012	8.9	8.2	4.5	10.1	9.1	5.1	4.1	3.9	2.3	0.5	5.6	Alfalfa, dehydr., CP < 16% DM
6.10.1	Lucerne silage 2nd harvest UK 2012	8.3	7.7	4.3	9.6	8.6	5.0	3.7	4.3	2.4	0.4	7.0	Alfalfa, dehydr., CP 18-19% DM
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	7.7	7.1	4.3	9.1	8.3	5.0	4.0	3.8	3.3	0.5	16.1	Alfalfa, dehydr., CP 22-25% DM
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	8.1	7.4	4.3	9.4	8.4	5.0	3.5	3.0	3.3	0.5	18.0	Alfalfa, dehydr., CP 22-25% DM
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	9.6	8.9	5.3	10.7	9.7	5.9	7.8	6.5	3.3	0.5	8.7	Alfalfa, dehydr., CP 22-25% DM
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	9.5	8.8	5.2	10.6	9.7	5.9	7.4	6.5	3.2	0.6	9.4	Alfalfa, dehydr., CP 22-25% DM
6.10.1	Clover-grass silage DE 2012	7.2	6.7	4.0	8.6	7.9	4.8	4.3	3.5	1.8	0.6	5.8	Grass, dehydr.
6.10.5	Lucerne pellets UK 2012	7.9	7.3	4.0	9.2	8.3	4.7	3.6	4.1	2.4	0.6	5.4	Alfalfa, dehydr., CP 17-18% DM
6.6.3	Grass, wilted and ensiled NL 2011	9.3	8.5	5.0	10.5	9.4	5.6	8.1	6.4	3.0	0.7	9.0	Grass, dehydr.

Table 12. Energy values and standardised ileal digestible amino acids of new feed materials (EvaPig®).

		MJ/kg DM						g/kg DM					
no	Name	DE grow. pig	ME grow. pig	NE grow. pig	DE adult pig	ME adult pig	NE adult pig	SID Lys	SID Thr	SID Met	SID Cys	SID Val	Reference feed ingredient
7.1.1	*Algae Spirulina* UK 2012	18.6	16.9	10.9	18.6	16.8	10.8	28.6	30.0	15.4	7.2	38.4	Fish meal, CP 65%
7.1.1	Algae *Chlorella scenedesmus* NL 2012	13.7	12.9	9.0	13.7	12.9	9.0	20.6	17.7	8.2	3.7	19.9	Fish meal, CP 62%
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	21.5	19.9	14.9	21.5	19.8	14.8	21.1	15.8	8.4	2.0	24.8	Fish meal, CP 62%
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	16.2	14.7	9.4	16.2	14.7	9.3	30.7	22.3	11.2	2.9	35.6	Fish meal, CP 62%
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	24.0	22.1	16.5	24.0	22.0	16.4	21.9	16.4	8.3	2.0	26.8	Fish meal, CP 62%
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	18.3	16.4	10.2	18.3	16.4	10.2	33.8	25.5	11.6	3.4	41.5	Fish meal, CP 62%
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	23.1	21.4	16.4	23.1	21.4	16.3	21.3	15.0	7.6	1.9	23.5	Fish meal, CP 62%
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	16.4	14.8	9.2	16.4	14.8	9.2	33.3	23.6	11.3	3.0	37.5	Fish meal, CP 62%
10.11.1	Mussel *Mytilus edulis* meal SE 2013	18.8	17.0	11.1	18.8	17.0	11.1	44.5	28.1	15.8	7.2	27.4	Fish meal, CP 65%
10.11.1	Mussel *Mytilus edulis* meal SE 2012	18.9	17.2	11.3	18.9	17.1	11.2	44.1	27.2	14.2	6.7	35.3	Fish meal, CP 65%

3.4.2 The Dutch feed evaluation system: Energy and protein values

Table 13. Energy values and standardised ileal digestible amino acids of organically produced cereals and protein feed ingredients (CVB).

no	Name	kg DM	MJ/kg DM	g/kg DM					Reference feed ingredient
		EW	NEv	SID Lys	SID Met	SID Cys	SID Thr	SID Val	
1.1.1	Barley FI 2011	1.22	10.7	3.1	2.0	1.8	3.0	4.3	Barley
1.11.1	Wheat FI 2011	1.30	11.5	3.0	2.3	2.5	3.3	5.0	Wheat
1.4.1	Oats FI 2011	1.22	10.7	4.8	2.2	2.5	3.4	5.5	Oats
2.14.2	Rape seed meal UK 2012	0.99	8.8	14.0	6.5	5.3	11.6	13.8	Rapeseed expeller
2.14.2	Rape seed, expeller FI 2012	1.19	10.5	15.7	6.5	5.0	11.8	14.0	Rapeseed expeller
2.18.8	Soya bean pulp FI 2011	1.35	11.9	18.2	4.9	3.5	11.1	13.9	Soyabean meal
2.8.1	Linseed UK 2012	1.01	8.9	11.4	6.0	4.7	11.0	14.2	Linseed exp.
3.11.1	Peas FI 2012	1.26	11.1	14.2	2.3	2.6	7.0	8.7	Peas
3.11.1	Peas UK 2012	1.25	11.0	10.7	1.9	1.6	5.5	6.5	Peas
3.13.1	Grass pea AT 2011	1.16	10.2	16.8	3.0	3.3	9.1	11.3	Horse beans, white
3.15.1	Sainfoin AT 2011	1.33	11.7	14.7	4.8	3.0	9.0	11.1	Horse beans, white
3.15.1	Sainfoin, dehulled AT 2011	1.41	12.4	18.8	6.3	3.6	11.4	14.0	Horse beans, white
3.7.1	Faba beans UK 2012	1.17	10.3	16.4	2.3	2.0	8.3	11.2	Horse beans, white
3.7.1	Faba beans FI 2011	1.15	10.2	17.5	2.5	2.6	9.3	12.5	Horse beans, white
3.9.1	Sweet lupin UK 2012	1.07	9.4	14.4	2.0	3.1	10.0	11.4	Lupins, CP < 335 g/kg
4.8.1	Potato, raw FI 2011	1.04	9.1	2.9	1.2	0.5	1.7	2.8	Potatoes, dehydr.

Table 14. Energy values and standardised ileal digestible amino acids of organically produced roughages (CVB).

no	Name	kg DM	MJ/kg DM	g/kg DM					Reference feed ingredient
		EW	NEv	SID Lys	SID Met	SID Cys	SID Thr	SID Val	
6.10.1	Lucerne fresh UK 2012	0.70	6.0	7.3	3.9	0.2	5.9	9.1	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage UK 2012	0.56	4.9	3.6	2.2	0.1	3.5	5.0	Alfalfa meal, dehydrated, CP 140-160 g/kg
6.10.1	Lucerne silage 2nd harvest UK 2012	0.54	4.7	2.7	2.3	0.1	3.5	5.9	Alfalfa meal, dehydrated, CP 160-180 g/kg
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	0.55	4.8	2.7	3.1	0.1	2.8	10.9	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	0.56	4.9	2.4	3.1	0.1	2.4	15.1	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	0.61	5.3	5.3	3.1	0.1	5.2	7.3	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	0.60	5.3	5.0	3.0	0.1	5.1	7.8	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Clover-grass silage DE 2012	0.50	4.4	2.7	1.3	0.3	2.2	3.6	Grass meal CP < 140 g/kg
6.10.4	Lucerne pellets UK 2012	0.57	5.0	2.9	2.3	0.2	3.5	4.7	Alfalfa meal, dehydrated, CP 140-160 g/kg
6.6.3	Grass, wilted and ensiled NL 2011	0.68	6.0	5.0	2.2	0.3	4.0	5.5	Grass meal CP < 140 g/kg

Table 15. Energy values and standardised ileal digestible amino acids of new feed materials (CVB).

no	Name	kg DM	MJ/kg DM	g/kg DM					Reference feed ingredient
		EW	NEv	SID Lys	SID Met	SID Cys	SID Thr	SID Val	
7.1.1	Algae *Spirulina* UK 2012	1.17	10.3	27.5	14.8	6.2	28.8	37.3	Fish meal, CP > 680 g/kg
7.1.1	Algae *Chlorella scenedesmus* NL 2012	0.91	8.0	19.8	7.8	3.2	16.9	19.3	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	1.80	15.8	20.3	8.0	1.7	15.2	24.0	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	0.96	8.5	29.5	10.7	2.5	21.4	34.5	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	2.03	17.9	21.1	7.9	1.7	15.8	26.0	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	1.07	9.4	32.4	11.1	2.9	24.5	40.3	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	2.01	17.7	20.5	7.3	1.6	14.4	22.9	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	0.93	8.2	32.0	10.8	2.6	22.6	36.4	Fish meal, CP < 580 g/kg
10.11.1	Mussel *Mytilus edulis* meal SE 2013	1.21	10.7	42.7	15.1	6.2	27.0	26.6	Fish meal, CP 630-680 g/kg
10.11.1	Mussel *Mytilus edulis* meal SE 2012	1.24	10.9	42.3	13.6	5.7	26.1	25.4	Fish meal, CP 630-680 g/kg

3.4.3 The Danish feed evaluation system: Energy and protein values

Table 16. Energy values and standardised ileal digestible amino acids of organically produced cereals and protein feed ingredients (VSP).

		g/kg DM							
no	Name	FEsv	FEso	SID Lys	SID Met	SID Cys	SID Tre	SID Val	Reference feed ingredient
1.1.1	Barley FI 2011	1.20	1.20	3.0	2.0	1.8	2.8	4.0	BYG, vår, gns. 2011-2013
1.11.1	Wheat FI 2011	1.33	1.31	2.8	2.2	2.3	3.1	4.7	HVEDE, gns. 2011-2013
1.4.1	Oats FI 2011	1.03	1.06	4.5	2.1	2.3	3.1	5.3	HAVRE, 2013
2.14.2	Rape seed meal UK 2012	0.96	1.02	15.1	7.2	6.4	12.9	15.2	RAPSSKRÅFODER, lavt glukosinolatindhold
2.14.2	Rape seed, expeller FI 2012	1.12	1.18	16.7	7.1	6.0	13.0	15.3	RAPSSKRÅFODER, lavt glukosinolatindhold
2.18.8	Soya bean pulp FI 2011	1.49	1.49	19.3	5.2	3.8	11.9	14.9	SOJASKRÅFODER, afskallet toastet
2.8.1	Linseed UK 2012	1.35	1.35	13.5	7.1	5.5	12.8	18.2	HØRFRØ
3.11.1	Peas FI 2012	1.20	1.21	15.9	2.7	2.9	7.7	9.5	ÆRTER
3.11.1	Peas UK 2012	1.21	1.22	11.7	2.1	1.7	5.8	6.9	ÆRTER
3.13.1	Grass pea AT 2011	1.07	1.09	15.0	2.5	3.3	8.2	10.0	HESTEBØNNER, gennemsnit af 3 sorter
3.15.1	Sainfoin AT 2011	1.15	1.17	13.1	4.0	3.0	8.1	9.8	HESTEBØNNER, gennemsnit af 3 sorter
3.15.1	Sainfoin, dehulled AT 2011	1.17	1.19	17.0	5.4	3.6	10.4	12.6	HESTEBØNNER, gennemsnit af 3 sorter
3.7.1	Faba beans UK 2012	1.08	1.10	14.5	1.9	2.0	7.4	9.8	HESTEBØNNER, gennemsnit af 3 sorter
3.7.1	Faba beans FI 2011	1.04	1.06	15.7	2.1	2.6	8.4	11.0	HESTEBØNNER, gennemsnit af 3 sorter
3.9.1	Sweet lupin UK 2012	0.91	1.02	12.9	1.9	2.8	8.9	10.1	LUPIN, blå

Table 17. Energy values and standardised ileal digestible amino acids of organically produced roughages (VSP).

		g/kg DM							
no	Name	FEsv	FEso	SID Lys	SID Met	SID Cys	SID Tre	SID Val	Reference feed ingredient
6.10.1	Lucerne fresh UK 2012	0.33	0.45	9.9	3.4	1.1	6.8	9.8	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Lucerne silage UK 2012	0.36	0.49	4.1	1.6	0.8	3.3	4.4	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Lucerne silage 2nd harvest UK 2012	0.34	0.46	3.4	1.8	0.6	3.7	5.8	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	0.34	0.46	3.6	2.6	0.9	3.2	11.4	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	0.32	0.44	3.2	2.7	0.8	2.7	16.0	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	0.31	0.43	7.0	2.6	0.9	5.7	7.5	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	0.32	0.44	6.5	2.5	0.9	5.6	8.0	LUCERNEGRØNMEL (lucernepiller)
6.10.1	Clover-grass silage DE 2012	0.37	0.49	2.8	1.0	0.4	2.3	3.7	GRÆSGRØNMEL (grønpiller)
6.10.4	Lucerne pellets UK 2012	0.31	0.44	3.3	1.7	0.9	3.4	4.3	LUCERNEGRØNMEL (lucernepiller)
6.6.3	Grass, wilted and ensiled NL 2011	0.41	0.53	6.2	2.1	0.5	5.0	6.9	GRÆSGRØNMEL (grønpiller)

Table 18. Energy values and standardised ileal digestible amino acids of new feed materials (VSP).

		g/kg DM							
no	Name	FEsv	FEso	SID Lys	SID Met	SID Cys	SID Tre	SID Val	Reference feed ingredient
7.1.1	Algae *Spirulina* UK 2012	1.36	1.32	29.6	16.5	7.7	31.7	40.2	FISKEMEL
7.1.1	Algae *Chlorella scenedesmus* NL 2012	1.10	1.06	21.0	8.6	3.9	18.4	20.5	FISKEMEL
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	1.96	1.88	21.7	8.8	2.1	16.6	25.7	FISKEMEL
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	1.16	1.12	31.7	11.9	3.1	23.5	37.1	FISKEMEL
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	2.21	2.13	22.6	8.8	2.2	17.3	27.9	FISKEMEL
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	1.31	1.26	35.0	12.4	3.6	27.0	43.4	FISKEMEL
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	2.18	2.10	21.8	8.0	2.0	15.7	24.4	FISKEMEL
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	1.15	1.11	34.4	12.0	3.2	24.9	39.2	FISKEMEL
10.11.1	Mussel *Mytilus edulis* meal SE 2013	1.41	1.36	46.0	16.8	7.7	29.7	28.6	FISKEMEL
10.11.1	Mussel *Mytilus edulis* meal SE 2012	1.43	1.38	45.5	15.2	7.2	28.7	27.3	FISKEMEL

3.4.4 *In vitro* digestibilities and calculated standardised amino acid digestibilities

Table 19. *In vitro* digestibilities and standardised ileal digestibility of protein and amino acids of organically produced cereals and protein feed ingredients (Boisen, 2007).

no	Name	*In vitro* ileal digestibility, %		*In vitro* total tract digestibility, %	SIDCP	Standardised ileal digestibility, %									
		dDM	dN	dOM	%	lys	tre	met	cys	ile	leu	val	his	fen	tyr
1.1.1	Barley FI 2011	77	85	85	71	74	67	78	74	75	76	75	75	76	77
1.11.1	Wheat FI 2011	85	93	90	86	85	82	89	87	88	88	87	88	88	88
1.4.1	Oats FI 2011	72	91	78	75	82	73	84	82	82	83	81	82	83	83
2.14.2	Rape seed meal UK 2012	62	83	81	77	79	76	80	78	79	79	79	79	78	79
2.14.2	Rape seed, expeller FI 2012	65	85	85	78	82	79	82	80	81	81	81	81	80	81
2.18.8	Soya bean pulp FI 2011	50	90	87	81	85	79	84	78	85	85	83	85	85	85
3.11.1	Peas FI 2012	76	94	91	87	91	86	89	87	90	90	89	90	90	91
3.11.1	Peas UK 2012	76	94	91	84	90	84	87	83	88	89	87	88	88	89
3.13.1	Grass pea AT 2011	70	89	80	82	86	81	83	82	85	85	84	85	84	85
3.15.1	Sainfoin, dehulled AT 2011	79	93	93	90	92	89	92	89	91	91	90	92	91	91
3.7.1	Faba beans UK 2012	76	86	91	81	84	79	81	78	83	83	82	83	83	83
3.7.1	Faba beans FI 2011	71	90	87	84	87	82	83	81	86	87	85	86	86	87
4.8.1	Potato, raw FI 2011	52	85	64	44	64	32	67	35	59	55	62	58	55	64
4.8.2	Potato, cooked FI 2011	85	94	95	83	87	77	88	78	86	84	87	86	85	87

Table 20. *In vitro* digestibilities and standardised ileal digestibility of protein and amino acids of organically produced roughages (Boisen, 2007).

no	Name	*In vitro* ileal digestibility; %		*In vitro* total tract digestibility, %	SIDCP	Standardised ileal digestibility, %									
		dDM	dN	dOM	%	lys	tre	met	cys	ile	leu	val	his	fen	tyr
6.10.1	Lucerne fresh UK 2012	60	86	83	77	81	75	81	63	81	81	80	80	81	81
6.10.1	Lucerne silage UK 2012	41	81	58	57	66	54	69	42	67	68	65	62	65	68
6.10.1	Lucerne silage 2nd harvest UK 2012	39	83	60	63	63	55	70	25	70	71	69	67	68	74
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	40	83	62	67	63	49	74	39	74	74	75	59	71	67
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	40	84	60	69	61	44	75	33	75	75	74	57	72	64
6.10.1	Lucerne silage 3rd harvest DE 2012	51	84	75	71	76	70	76	57	76	77	75	73	75	74
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	43	81	69	65	72	64	73	39	72	72	71	68	68	71
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	47	83	68	68	74	67	75	46	74	75	74	71	73	69
6.10.1	Extruded silage DE 2013	44	85	64	73	61	65	76	43	75	75	79	59	73	63
6.10.1	Chopped silage DE 2013	45	86	66	74	76	69	77	50	77	77	76	72	75	75
6.10.1	Clover-grass silage DE 2012	41	85	57	57	65	48	67		68	69	67	44	64	67
6.10.4	Lucerne pellets UK 2012	38	82	53	58	63	53	69	44	67	67	65	63	65	65
6.6.3	Grass, wilted and ensiled NL 2011	48	87	70	71	77	69	77	26	77	78	77	72	76	78

Table 21. *In vitro* digestibilities and standardised ileal digestibility of protein and amino acids of new feed materials (Boisen, 2007).

no	Name	*In vitro* ileal digestibility, %		*In vitro* total tract digestibility, %	SIDCP	Standardised ileal digestibility, %									
		dDM	dN	dOM	%	lys	tre	met	cys	ile	leu	val	his	fen	tyr
7.1.1	Algae *Spirulina* UK 2012	77	77	78	75	76	75	76	74	76	76	76	75	76	76
7.1.1	Algae *Chlorella scenedesmus* NL 2012	58	60	62	53	57	54	57	50	55	56	56	52	55	56
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	85	78	85	76	77	75	77	71	77	77	77	77	76	77
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	79	78	77	76	77	75	77	71	77	77	77	77	76	77
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	83	77	83	75	76	74	76	69	76	76	76	76	75	76
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	72	75	74	72	73	72	74	67	74	74	74	74	73	74
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	87	82	87	80	81	80	81	76	81	81	81	81	80	81
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	78	81	77	79	80	79	79	74	80	80	80	80	79	80
10.11.1	Mussel *Mytilus edulis* meal SE 2012	89	90	91	89	90	89	90	89	89	89	89	89	89	89

3.4.5 The British feed evaluation system: Energy values

Table 22. Energy values of organically produced cereals, protein feed ingredients and roughages (The British Society of Animal Science).

no	Name	ED	DE	NE	Reference feed ingredient
		%	MJ/kg DM		(Sauvant 2004)
1.1.1	Barley FI 2011	81	14.8	11.2	Barley
1.11.1	Wheat FI 2011	88	16.3	12.3	Wheat, soft
1.4.1	Oats FI 2011	64	12.4	9.4	Oats
2.14.2	Rape seed meal UK 2012	68	14.6	8.9	Rapeseed meal
2.14.2	Rape seed, expeller FI 2012	68	15.3	10.1	Rapeseed meal
2.18.8	Soya bean pulp FI 2011	85	19.2	12.5	Soybean meal
2.8.1	Linseed UK 2012	73	15.8	10.1	Linseed, ful fat
3.11.1	Peas FI 2012	88	16.2	11.6	Pea
3.11.1	Peas UK 2012	88	16.0	11.4	Pea
3.13.1	Grass pea AT 2011	86	16.2	11.0	Faba bean, white flowers
3.15.1	Sainfoin AT 2011	86	17.3	10.8	Faba bean, white flowers
3.15.1	Sainfoin, dehulled AT 2011	86	17.8	11.4	Faba bean, white flowers
3.7.1	Faba beans UK 2012	86	16.3	10.9	Faba bean, white flowers
3.7.1	Faba beans FI 2011	86	16.2	10.7	Faba bean, white flowers
3.9.1	Sweet lupin UK 2012	77	15.7	9.4	Lupin, blue
6.10.1	Lucerne fresh UK 2012	51	9.5	5.3	Alfalfa, dehydr., CP 22-25 % dry matter
6.10.1	Lucerne silage UK 2012	40	7.4	3.8	Alfalfa, dehydr., CP <16 % dry matter
6.10.1	Lucerne silage 2nd harvest UK 2012	44	8.1	4.0	Alfalfa, dehydr., CP 18-19 % dry matter
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	51	9.5	4.8	Alfalfa, dehydr., CP 22-25 % dry matter
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	51	9.4	4.7	Alfalfa, dehydr., CP 22-25 % dry matter
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	51	9.1	4.9	Alfalfa, dehydr., CP 22-25 % dry matter
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	51	9.3	5.0	Alfalfa, dehydr., CP 22-25 % dry matter
6.10.1	Clover-grass silage DE 2012	38	6.8	3.3	Grass, dehydrated
6.10.4	Lucerne pellets UK 2012	40	7.2	3.4	Alfalfa, dehydr., CP <16 % dry matter
6.6.3	Grass, wilted and ensiled NL 2011	38	7.1	3.6	Grass, dehydrated

Table 23. Energy values of new feed materials (The British Society of Animal Science).

no	Name	ED	DE	NE	Reference feed ingredient
		%	MJ/kg DM		(Sauvant 2004)
7.1.1	Algae *Spirulina* UK 2012	85	18.6	10.8	Fish meal, protein 65 %
7.1.1	Algae *Chlorella scenedesmus* NL 2012	85	13.7	8.5	Fish meal, protein 65 %
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	85	21.5	15.5	Fish meal, protein 65 %
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	85	16.2	9.1	Fish meal, protein 65 %
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	85	24.0	17.5	Fish meal, protein 65 %
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	85	18.3	10.2	Fish meal, protein 65 %
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	85	23.1	17.3	Fish meal, protein 65 %
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	85	16.4	8.9	Fish meal, protein 65 %
10.11.1	Mussel *Mytilus edulis* meal SE 2013	85	18.8	11.1	Fish meal, protein 65 %
10.11.1	Mussel *Mytilus edulis* meal SE 2012	85	18.9	11.3	Fish meal, protein 65 %

3.4.6 The German feed evaluation system: Energy values

Table 24. Energy values of organically produced feed ingredients and new feed materials (GfE).

no	Name	ME MJ/kg DM
1.1.1	Barley FI 2011	15.2
1.11.1	Wheat FI 2011	15.6
1.4.1	Oats FI 2011	15.6
2.14.2	Rape seed mealUK 2012	15.8
2.14.2	Rape seed, expeller FI 2012	16.8
2.18.8	Soya bean pulp FI 2011	17.2
2.8.1	Linseed UK 2012	16.6
3.11.1	Peas FI 2012	15.6
3.11.1	Peas UK 2012	14.1
3.13.1	Grass pea AT 2011	15.6
3.15.1	Sainfoin AT 2011	15.4
3.15.1	Sainfoin, dehulled AT 2011	16.4
3.7.1	Faba beans UK 2012	15.3
3.7.1	Horse beans FI 2011	15.4
3.9.1	Sweet lupins UK 2012	15.4
4.8.1	Potato, raw FI 2011	14.3
7.1.1	Algae *Spirulina* UK 2012	16.8
7.1.1	Algae *Chlorella scenedesmus* NL 2012	12.6
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	19.8
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	14.6
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	22.1
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	16.3
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	21.3
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	14.7
10.11.1	Mussel *Mytilus edulis* meal SE 2013	16.9
10.11.1	Mussel *Mytilus edulis* meal SE 2012	17.1

3.4.7 The Swiss feed evaluation system: Energy values

Table 25. Energy values of organically produced feed ingredients and new feed materials (Switzerland).

no	Name	DE MJ/kg DM
1.1.1	Barley FI 2011	14.8
1.11.1	Wheat FI 2011	16.3
1.4.1	Oats FI 2011	12.8
3.11.1	Peas FI 2012	16.2
3.11.1	Peas UK 2012	14.7
3.13.1	Grass pea AT 2011	14.8
3.15.1	Sainfoin, dehulled AT 2011	16.0
3.7.1	Faba beans UK 2012	14.3
3.7.1	Horse beans FI 2011	14.2
4.8.1	Potato, raw FI 2011	15.3
4.8.2	Potato, cooked FI 2011	15.5
7.1.1	Algae *Spirulina* UK 2012	18.6
7.1.1	Algae *Chlorella scenedesmus* NL 2012	14.0
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	16.3
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	18.3
9.16.2	*Hermetia illucens* meal ´kichen waste´ defatted CH 2012	16.4
10.11.1	Mussel *Mytilus edulis* meal SE 2013	18.9
10.11.1	Mussel *Mytilus edulis* meal SE 2012	19.0

3.5 Energy values for Poultry

3.5.1 The Finnish feed evaluation system: Energy values

Table 26. Energy values of organically produced feed ingredients and new feed materials for poultry (MTT).

no	Name	ME MJ/kg DM
1.1.1	Barley FI 2011	14.0
1.11.1	Wheat FI 2011	14.6
1.4.1	Oats FI 2011	13.4
2.14.2	Rape seed meal UK 2012	10.0
2.14.2	Rape seed, expeller FI 2012	11.3
2.18.8	Soya bean pulp FI 2011	10.5
2.8.1	Linseed UK 2012	10.7
3.11.1	Peas FI 2012	13.2
3.11.1	Peas UK 2012	12.8
3.13.1	Grass pea AT 2011	11.9
3.15.1	Sainfoin AT 2011	10.9
3.15.1	Sainfoin, dehulled AT 2011	12.7
3.7.1	Faba beans UK 2012	11.6
3.7.1	Horse beans FI 2011	11.6
3.9.1	Sweet lupins UK 2012	8.7
4.8.1	Potato, raw FI 2011	14.5
6.10.1	Lucerne fresh UK 2012	4.4
6.10.1	Lucerne silage UK 2012	3.5
6.10.1	Lucerne silage 2nd harvest UK 2012	3.5
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	4.3
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	3.7
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	3.8
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	3.8
6.10.1	Clover-grass silage DE 2012	3.1
6.10.4	Lucerne pellets UK 2012	3.3
6.6.3	Grass, wilted and ensiled NL 2011	4.0
7.1.1	*Algae Spirulina* UK 2012	15.3
7.1.1	*Algae Chlorella scenedesmus* NL 2012	12.3
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	19.3
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	13.4
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	21.4
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	14.9
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	21.0
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	13.4
10.11.1	Mussel *Mytilus edulis* meal SE 2013	15.5
10.11.1	Mussel *Mytilus edulis* meal SE 2012	15.7

3.5.2 The Dutch feed evaluation system: Energy and protein values

Table 27. Energy and protein values of organically produced cereals and protein feed ingredients for poultry (CVB).

no	Name	Broilers	Poultry	Laying hens	g/kg DM			Reference feed ingredient
		MJ/kg DM			dig Lys	dig Met	dig Cys	
1.1.1	Barley FI 2011	11.3	14.0	14.1	2.7	1.8	1.6	Barley
1.11.1	Wheat FI 2011	13.8	14.8	14.9	3.0	2.3	2.3	Wheat
1.4.1	Oats FI 2011	12.7	13.4	13.7	3.6	2.0	2.1	Oats
2.14.2	Rape seed meal UK 2012	9.7	10.1	10.6	15.0	6.7	5.2	Rapeseed expeller
2.14.2	Rape seed, expeller FI 2012	11.3	11.6	12.4	16.8	6.6	4.9	Rapeseed expeller
2.18.8	Soya bean pulp FI 2011	8.9	12.0	12.2	17.8	4.6	3.4	Soyabean meal
2.8.1	Linseed UK 2012	-	9.3	9.9	7.8	4.0	3.1	Linseed expeller
3.11.1	Peas FI 2012	12.6	13.3	13.4	14.5	2.7	2.8	Peas
3.11.1	Peas UK 2012	12.3	12.9	13.0	10.9	2.2	1.8	Peas
3.13.1	Grass pea AT 2011	12.3	13.2	13.2	15.9	3.0	3.3	Horse beans
3.15.1	Sainfoin AT 2011	11.4	11.5	11.8	13.9	4.8	2.9	Horse beans
3.15.1	Sainfoin, dehulled AT 2011	13.3	13.5	13.8	17.7	6.3	3.5	Horse beans
3.7.1	Faba beans UK 2012	12.1	12.9	12.9	15.5	2.3	2.0	Horse beans
3.7.1	Faba beans FI 2011	11.9	12.8	12.9	16.6	2.5	2.5	Horse beans
3.9.1	Sweet lupins UK 2012	9.2	8.9	9.1	14.6	2.2	3.2	Lupins, CP < 335 g/kg

Table 28. Energy and protein values of organically produced roughages for poultry (CVB).

no	Name	Broilers	Poultry	Laying hens	g/kg DM			Reference feed ingredient
			MJ/kg DM		dig Lys	dig Met	dig Cys	
6.10.1	Lucerne fresh UK 2012	-	6.4	6.4	10.6	3.7	1.2	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage UK 2012	-	3.4	3.4	4.1	1.6	0.8	Alfalfa meal, dehydrated, CP 140-160 g/kg
6.10.1	Lucerne silage 2nd harvest UK 2012	-	4.3	4.4	3.6	1.9	0.7	Alfalfa meal, dehydrated, CP 160-180 g/kg
6.10.1	Lucerne silage 2nd harvest extruded DE 2012	-	5.1	5.2	3.9	2.8	1.0	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage 2nd harvest chopped DE 2012	-	5.2	5.3	3.5	2.9	0.8	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage 3rd harvest extruded DE 2012	-	5.6	5.7	7.8	2.9	1.0	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Lucerne silage 3rd harvest chopped DE 2012	-	5.5	5.6	7.4	2.8	1.0	Alfalfa meal, dehydrated, CP >180 g/kg
6.10.1	Clover-grass silage DE 2012	-	3.2	3.3	2.5	1.0	0.3	Grass meal CP < 140 g/kg
6.10.4	Lucerne pellets UK 2012	-	3.4	3.4	3.3	1.7	0.9	Alfalfa meal, dehydrated, CP 140-160 g/kg
6.6.3	Grass, wilted and ensiled NL 2011	-	3.8	3.9	4.7	1.6	0.4	Grass meal CP < 140 g/kg

Table 29. Energy and protein values of new feed materials for poultry (CVB).

no	Name	Broilers	Poultry	Laying hens	g/kg DM			Reference feed ingredient
			MJ/kg DM		dig Lys	dig Met	dig Cys	
7.1.1	Algae *Spirulina* UK 2012	14.0	15.8	16.2	28.0	15.4	7.4	Fish meal, CP > 680 g/kg
7.1.1	Algae *Chlorella scenedesmus* NL 2012	11.3	12.4	12.8	19.9	8.0	3.8	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* larvae ´MBM´ dried, full fat CH 2012	18.0	19.6	21.3	20.4	8.2	2.0	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* meal ´MBM´ defatted CH 2012	12.6	13.8	14.0	30.2	11.0	3.0	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* larvae ´CHO´ dried, full fat CH 2012	20.1	21.8	23.8	21.2	8.0	2.1	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* meal ´CHO´ defatted CH 2012	13.6	15.5	15.7	32.7	11.3	3.5	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* larvae ´kitchen waste´ full fat CH 2012	19.8	21.3	23.3	20.6	7.4	2.0	Fish meal, CP < 580 g/kg
9.16.2	*Hermetia illucens* meal ´kitchen waste´ defatted CH 2012	12.2	13.9	14.0	32.3	11.1	3.1	Fish meal, CP < 580 g/kg
10.11.1	Mussel *Mytilus edulis* meal SE 2013	14.2	16.1	16.6	43.5	15.8	7.5	Fish meal, CP 630-680 g/kg
10.11.1	Mussel *Mytilus edulis* meal SE 2012	14.3	16.2	16.8	43.1	14.2	6.9	Fish meal, CP 630-680 g/kg

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5 Links

EU feed catalogue: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0068&from=EN

The French feed evaluation system for pigs: http://www.evapig.com/IMG/pdf/EvaPigManualEquations-3.pdf

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The Finnish feed evaluation system for poultry: https://portal.mtt.fi/portal/page/portal/Rehutaulukot/feed_tables_english/feed_tables/basis_of_calculations/energy_value_poultry

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